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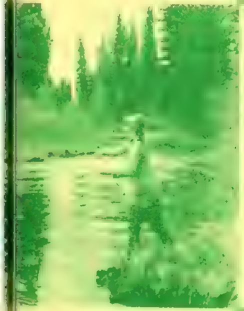
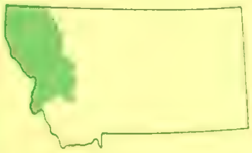
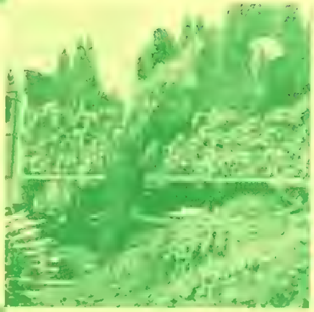
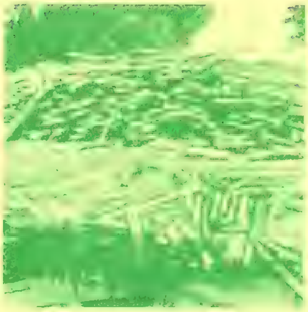
U. S. Forest Service Resource Bulletin INT-1

FOREST RESOURCES OF WESTERN MONTANA

INTERMOUNTAIN FOREST & RANGE
EXPERIMENT STATION
FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE
OGDEN, UTAH
JOSEPH F. PECHANEC, DIRECTOR

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The survey of Western Montana was conducted as part of the continuing nationwide Forest Survey. Work started in 1953 under the Northern Rocky Mountain Forest Experiment Station, Missoula, Montana. Fieldwork was completed in 1958 under the Intermountain Station after consolidation of the two Stations.

The Northern Region of the U.S. Forest Service assisted in fieldwork and compilation.

1963

THE FOREST RESOURCE OF WESTERN MONTANA

HENRY J. PISSOT
HAROLD E. HANSON

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WESTERN MONTANA IS THAT PORTION OF THE STATE DRAINING TO THE PACIFIC OCEAN: THAT IS, THE AREA WEST OF THE CONTINENTAL DIVIDE. IT INCLUDES ALL OR PART OF THE FOLLOWING COUNTIES: DEERLODGE, FLATHEAD, GRANITE, LAKE, LEWIS AND CLARK, LINCOLN, MINERAL, MISSOULA, POWELL, RAVALLI, SANDERS, AND SILVER BOW.

FOREWORD

In 1925 the sawtimber volume in Western Montana was estimated to be about 37.5 billion board feet (*2*).[1] Forest Survey compilations in 1949 (*4*) based on field surveys prior to World War II raised the estimates to 39.7 billion. The most recent estimates, given in this report, show a present sawtimber volume of 73.5 billion board feet.

Startling though this difference is, it will not surprise anyone who has followed the history of timber utilization and inventory practices in this country. Inventories have been geared largely to obtaining estimates of currently merchantable timber, rather than the total stand. Also, timber cruisers through the years have traditionally been cautious souls. They have found it more acceptable practice to underestimate rather than risk an overestimate. These two factors — rapidly changing utilization and conservative estimates — have generally resulted in rapid obsolescence of inventory estimates.

The trend toward more intensive utilization during the period between old and new surveys is exemplified in Western Montana. Since World War II, the stumpage value of all species has risen. As a result, 1.5 million acres are today included as commercial that previously had been classified as noncommercial. This increase has been accompanied by a reduction of 1 million acres in nonstocked and seedling and sapling area and an increase of about 2.6 million acres of sawtimber. A substantial area within the 1910 burn has reached pole size, and about an equal area of the 1942 poletimber has become sawtimber.

Changes in the economic importance of species and closer utilization with respect to tree size have both contributed to higher current estimates. Prior to World War II, timber utilization rested heavily on white pine and ponderosa pine. Other species were far less valuable. As a consequence, even the early estimates of white pine volume were very realistic and those of ponderosa pine were not much in error. In contrast, the inventory of other species was at best very rough. Today there are 61 billion board feet of Douglas-fir, western larch, Engelmann spruce, lodgepole pine, and the minor species. This amounts to more than twice the volume of these species reported earlier.

Improved inventory techniques have been another major development. Estimates from earlier surveys were based largely on the compilation of public and private cruises, which varied greatly in objectives and standards. Although Forest Survey made check cruises to adjust estimates to a common standard, the total result could not be statistically evaluated for reliability. Estimates presented in this report are based on greatly improved sampling procedures that reduce the risk of bias.

Timber inventory procedures are constantly being improved. Although it is now possible with the sampling system used in Western Montana to estimate volumes within prescribed rates of accuracy, the need today is for additional information that describes management needs and opportunities. Currently this Experiment Station is giving much attention to the development of inventory systems that will do this.

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[1] Italicized numbers in parentheses indicate numbered references on page 17. International ¼-inch log rule is used throughout this report unless otherwise stated.

THE FOREST

Western Montana is a green country. Its many mountains are almost completely covered with coniferous timber. In fact, 80 percent of the 16.0 million acres west of the Continental Divide is classified as forest. However, the importance of the trees goes beyond the fact that they are almost everywhere. Along with the forest of northern Idaho this is some of the best timberland in the Rocky Mountains — best from the standpoint of volume yields, timber quality, and operability.

The 10.5 million acres of commercial timberland in Western Montana grow a dozen important species of trees. Here is the largest single block of western larch in the United States (about 51 percent of the national area). Ponderosa pine, inland Douglas-fir, western white pine, and spruce have also been important sources of industrial wood.

Lumbermen moved into this country late in the last century. Sawmills, plywood, pole, paper, and other wood-using industries today provide the principal employment in this part of the State and the principal manufacturing employment for the whole State.

Despite all the timber cutting that has taken place, most of the commercial forest still contains sawtimber stands. Two out of three acres are in the sawtimber category today; that is, they contain more than 1,500 board feet per acre in sawtimber trees.

Ponderosa pine stands attracted eastern lumbermen to Montana in the first place and since then have borne the brunt of the logging. However, three other types today exceed the ponderosa pine type in area: Douglas-fir, lodgepole pine, and larch. There is reason to presume that ponderosa pine may at one time have been the principal type. Much of the logged-over ponderosa pine area is now dominated by other species, mainly Douglas-fir.

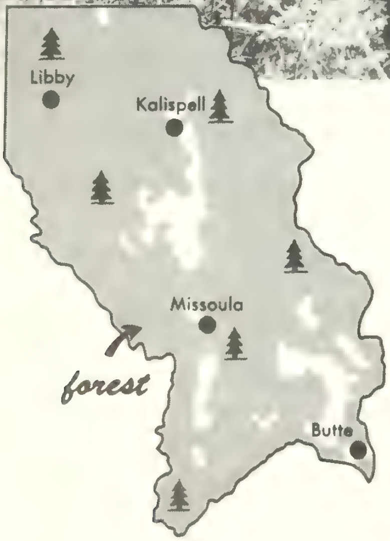
The commercial forest

	Million acres
Douglas-fir	2.8
Lodgepole pine	2.8
Larch	1.9
Ponderosa pine	1.7
Other types	1.3
Total	10.5

Western Montana has had a turbulent fire history. The years 1910, 1919, and 1926 stand out because of the extensive areas burned. Nevertheless, only 2 percent of the commercial forest is nonstocked. Natural restocking on most areas has been rapid. Larch and lodgepole pine have been particularly aggressive in reseeding burned areas.

Actually, the big problem in Western Montana has been too many rather than too few trees in the younger stands. Approximately 52 percent of the seedling-sapling, and pole stands are classed as "well stocked." Much of this area is really overstocked. The problem is most significant in the lodgepole pine, larch, and Douglas-fir types, which have about 95 percent of the well-stocked seedling-sapling, and pole stands in Western Montana. For these types, well-stocked seedling and sapling stands average about 3,700 trees per acre and pole stands about 1,360 trees. For sawtimber production, a stocking of not more than about 1,000 well-distributed stems per acre is desirable in seedling-sapling stands and fewer than 500 in poletimber stands. Thinning is urgently needed in the large area of overstocked stands which will still respond to treatment.

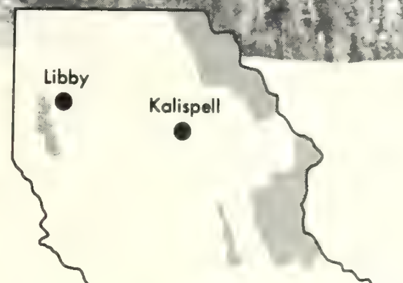
Although restocking of cutover areas has usually been prompt, the species, quality, and vigor of the restocking trees in many areas leave something to be desired. Therefore, better stand regeneration also appears to be a high priority management job in Western Montana. Management problems in this locality have been discussed in several recent reports (*3*, *5*, *7*).



PHOTOS: U.S.F.S.

Commercial forest of ponderosa pine in Kootenai National Forest. Almost two-thirds of Western Montana is covered by commercial forest. Trees are not confined to the higher mountain slopes as they are in eastern Montana and the Rockies to the south but extend down to and sometimes cover the valley floor.

	Million acres
Total land	**16.0**
Total forest	**12.7**
Commercial forest	**10.5**



	Million acres
Reserved-productive	0.9
Reserved-unproductive	.8
Unreserved-unproductive	.6
Total, noncommercial	2.3

PHOTOS: U.S.F.S.

Noncommercial forest such as this area on Kootenai National Forest constitutes about 18 percent of the forest area of Western Montana. This area is so classified because it is either nonproductive forest (mostly at the upper elevations) or is reserved from timber cutting, or both. The important reserved areas in Western Montana are Glacier National Park, Bob Marshall Wilderness, Selway Bitterroot Wilderness, Anaconda Pintlar Wilderness, Cabinet Mountain Wild Area, and Mission Mountain Wild Area. Watershed protection and recreation use rather than timber production are paramount in these areas.

Four and one-quarter million acres of old growth constitute another management problem. This timber, which occupies about 40 percent of the commercial forest area, is largely beyond rotation age — much of it more than 140 years old. Growth rates are low, and in many areas mortality is greater than growth. Some of this old growth is considered "high risk." That is, it is likely to be seriously decimated if not harvested within the next several decades.

These overage stands are very vulnerable to insects and disease. Large-scale insect infestations and disease epidemics can rapidly devastate extensive areas. The death of nearly 1.6 billion board feet[2] of spruce in Western Montana between 1952 and 1957 illustrates this danger. Although roughly half of this volume was salvaged by the end of 1957, this was done only at the expense of efficient sustained-yield management of the entire forest.

Dwarfmistletoe, though less dramatic than the spruce bark beetle, may be even more serious in its long-term impact on productivity. The toll from this insignificant looking parasite is mainly in the form of greatly reduced growth rates rather than outright mortality. Infected trees take much longer to reach merchantable size and some never get there at all. Extent of this growth loss is indicated by a recent survey[3] of mistletoe infection in the Clark Fork River drainage (about two-thirds of Western Montana). Within this drainage, about one-third of the commercial forest area is infected. Incidence

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[2] Estimate does not include losses on reserved lands.

[3] Graham, Donald P., Dwarfmistletoe surveys in the Clark Fork Timber Development Unit of Western Montana. U.S. Forest Serv., Intermountain Forest and Range Expt. Sta. In process.

A stand of lodgepole pine severely infested with dwarfmistletoe. Growth has been greatly retarded for many years and trees are finally dying. Photo: R. B. Herrington.

Logging in an area infested by spruce bark beetle on Lolo National Forest. Besides salvaging beetle-killed timber, this operation removed live infested trees as a control measure. Photo: U.S.F.S.

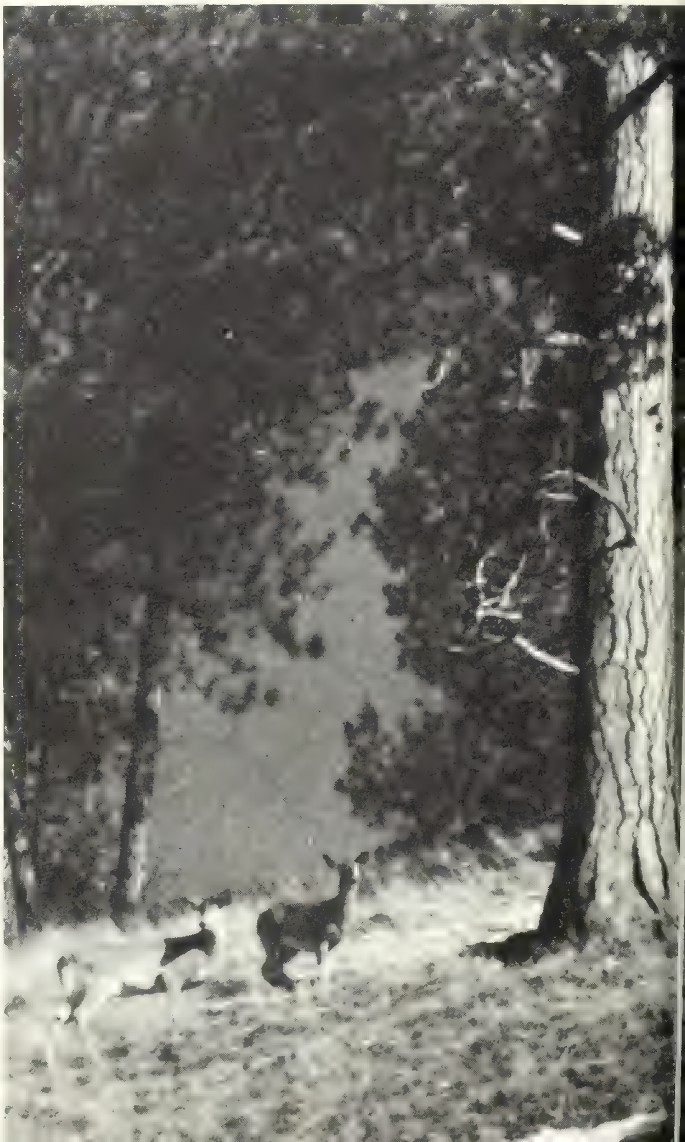
is especially high in the Douglas-fir, lodgepole pine, and western larch types. For the Clark Fork area alone, the annual loss in sawtimber growth is estimated as 70 to 80 million board feet.

Management is severely handicapped by an entirely inadequate road system. Although annual timber production goals are being met, much of the production is coming from the wrong places. Great areas of overmature timber with high mortality rates and consequent economic losses cannot be reached at present, and as a result many stands of lower priority are being logged. Similarly, many younger stands having high priority for cultural work cannot be reached.

Management problems, like those described above, can and will be brought under control. Improvement, however, will not be rapid. Markets must be developed, much more road construction is necessary, more silvicultural research is necessary, logging techniques for use on steep and unstable terrain must be developed, and finally a forward-looking program of thinning, pruning, and stand rehabilitation must be instituted.

Of the many products of Western Montana's forests, water may eventually provide the most far-reaching benefits. The water supply will be particularly significant for hydroelectric and irrigation development of downstream areas outside Western Montana. The Clark Fork and Kootenai river systems are principal headwaters of the Columbia River. The area has many full flowing streams such as the Blackfoot, Clark Fork, Flathead, Kootenai, and Thompson Rivers, that are significant both as a water supply and a recreational resource. Likewise, Flathead Lake and numerous smaller lakes scattered throughout the commercial and noncommercial forest are valuable from both standpoints. Practically all of this water falls on forest land.

Photos: U.S.F.S.



Photos on this page illustrate some of the attributes of Western Montana as an important national playground. Here are broad expanses of public land, beautiful and fishable lakes and streams, outstanding scenery, and fine hunting. Except for seashore, Western Montana offers a full range of outdoor environment from the very wild to the more or less domesticated.

The photo of boating and water skiing on Seeley Lake illustrates the rapidly increasing importance of recreation among the multiple uses of forests and waterways.

The photo on the right shows deer on winter ranges in the Salmon Lake area. Other big game are also important for hunting and as sightseeing attractions. For example, Western Montana provides some of the best elk hunting in the United States — more than 15,000 elk were taken by hunters in 1961. Here, too, is the largest remaining stronghold of the grizzly bear in the continental United States.

TIMBER VOLUME

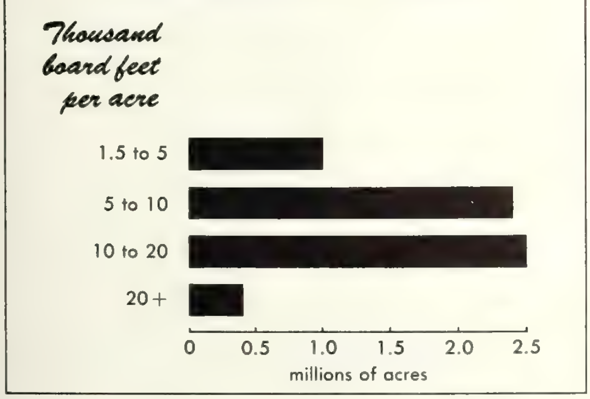
Western Montana has a lot of wood, more wood in fact than most states. The recent survey indicates a total merchantable stand of 19.5 billion cubic feet in trees 5 inches and larger. Only five states have more timber than this: Idaho, Washington, Oregon, California, and Alaska.

About two-thirds of the wood is in sawtimber trees that have an aggregate volume of 73.5 billion board feet. This sawtimber, of course, constitutes the main part of the presently utilizable wood supply in Western Montana. However, much of the 7 billion cubic feet of smaller trees is likewise available for harvesting. These harvestable small trees are in sawtimber stands and in pole stands that have virtually ceased to grow and should be cut as soon as possible. In the past, most of the trees cut have been sawtimber. The lack of markets for trees smaller than sawtimber size is one of the big utilization headaches in this region.

Commercial forests of sawtimber size are dominated by four species: Douglas-fir, western larch, Engelmann spruce, and ponderosa pine. One-third of the sawtimber volume is Douglas-fir and the four species combined make up about 80 percent of the total volume.

Western Montana is hardly in the class with the west coast in producing big trees. Nevertheless, this area compares favorably with much of the rest of the United States so far as capacity to grow trees is concerned. Four-tenths of all the board-foot volume of sawtimber is in trees 21 inches and larger. The table below shows how the more important species compare in size:

HOW PRESENT SAWTIMBER STANDS RANGE IN VOLUME



Average diameter of sawtimber trees

	Inches
Douglas-fir	16.2
Engelmann spruce	18.1
Western larch	18.0
Ponderosa pine	17.8
Lodgepole pine	13.1

Lodgepole pine lags far behind other species in size. Characteristically a small tree, its average diameter is reduced further by the usual overcrowding. Approximately four-fifths of the total cubic volume of lodgepole pine timber is in pole trees. Lodgepole pines 21 inches and larger are rare.

The average volume in sawtimber stands in Western Montana today is only 10,860 board feet per acre. This is because some of these stands have been partially cut. Others have produced less volume than they might have because of overcrowding. Still others are very old and have lost some of their original volume because of insects, disease, and other "eroding" factors.

That the commercial forest is potentially more productive is indicated by the following table based on the application of per-acre yield potentials (75 percent of full yields in yield tables) to the area of various site classes and types.

Harvest yield capabilities of commercial forest

Board feet per acre	Acres
30,000 and more	4,100,000
20,000 to 30,000	3,800,000
10,000 to 20,000	1,000,000
Less than 10,000	1,600,000

Western Montana has the potential for a sustained annual cut of about 2.1 billion board feet — nearly twice the current sawtimber cut. However, it can be realized only under fairly intensive management — much more intensive than is currently practiced.

The photos on this and the opposite page illustrate extremes in the timber situation in Western Montana. The larch and spruce stands are typical of the better sawtimber. They provide an indication of the potentialities of much of the forest in Western Montana.

The other extreme is illustrated by the lodgepole pine stand. Only 12 percent of the 2.7 million acres of lodgepole pine type is sawtimber. However, much of the 1.8 million acres of pole-size lodgepole pine timber is mature. Small by nature, this tree tends to crowd itself into stagnation. In years to come, some of this type should be converted to other species; much of the remainder will require thinning to keep the growth rate up to what it should be. At present the market for this large volume of small trees is extremely limited. Inability to market the lodgepole pine and small trees in other stands has seriously handicapped management efforts.

Sawtimber quality as measured by log grades also varies greatly among species. About 14 percent of all saw logs are grade 1. Species showing the highest percentage of grade 1 logs are western white pine (38 percent), western larch (35 percent), and ponderosa pine (21 percent). In sharp contrast are lodgepole pine, spruce, and Douglas-fir — all with less than 6 percent top-quality logs. Timber culture can considerably improve both timber quality and size.

Spruce sawtimber, Kootenai National Forest. Photo: U.S.F.S. ↑

Larch sawtimber, Flathead National Forest. Photo: U.S.F.S. ➡

⬅ Lodgepole pine poles, Flathead National Forest. Photo: U.S.F.S.

OWNERSHIP

Most timberland in Western Montana is in big holdings. Under present circumstances, this is conducive to enlightened management. Eighty-three percent of the commercial forest land is owned or administered by agencies and companies with sufficiently large holdings to make forestry feasible and with the capacity to practice forestry and multiple use management. Seventy-three percent of the commercial forest is in public holdings, principally the National Forests. One million acres, or 10 percent, is in industrial forest ownership. Several of the large private timber owners employ foresters and have an interest in forestry as an enterprise.

Small private owners have 17 percent of the commercial forest land. While these holdings include some of the best forest land, this property is divided among a large number of owners and the individual holding is small. For the most part, these small owners do not know how to manage their timberlands nor do they have the interest. As a consequence they pose one of the more serious forestry problems of the area. This situation is not peculiar to Western Montana: the low productivity of small ownerships is a problem over the whole Nation.

Ownership of commercial forest land

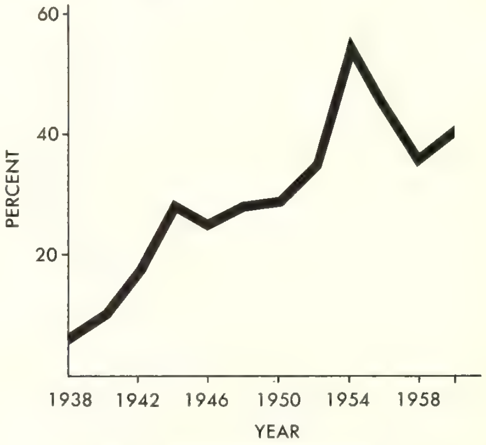
	Million acres
National Forest	6.7
Other Federal	.5
State, county, and municipal	.5
Industry	1.0
Other private	1.8
Total	10.5

Because so much of the forest is in public ownership, the future of the wood industries in Western Montana is tied closely to these lands and their management. However, the 7.7 million acres of publicly owned commercial forest land must be discounted somewhat in relation to private land. For the most part, public holdings are more remote and less productive than the privately owned forest.

Of the commercial forest, the public owns a very high proportion of the lower value, less accessible, and less easily operable area. This is indicated in a general way by the type of commercial forest in public and private ownership. Only half of the ponderosa pine land, which is readily accessible and has a high value, is in public ownership. By contrast, the public owns virtually all of the high-elevation inaccessible spruce and low-value lodgepole pine.

On the positive side, insofar as public lands are concerned, is the fact that higher elevations generally receive more precipitation, thus offsetting somewhat poorer soils and more severe physiographic conditions.

PROPORTION OF
WESTERN MONTANA SAWLOG PRODUCTION
FROM NATIONAL FORESTS



Public ownership of commercial forest land by types

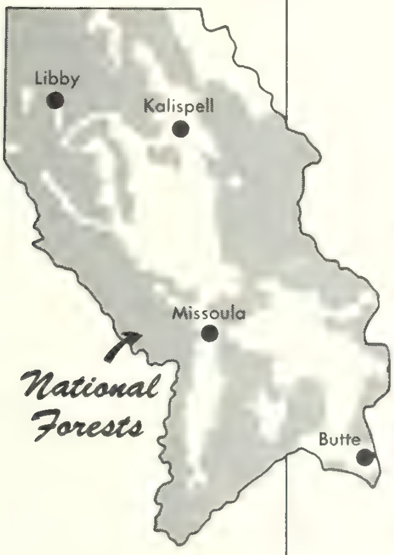
Type	Percent publicly owned
Ponderosa pine	51
Douglas-fir	68
Larch	76
Fir-spruce	93
Lodgepole, whitebark, and limber pine	83

In 1938, about 14 million board feet of sawtimber were logged on the National Forests. This was 7 percent of the total cut in this part of the State. Between 1938 and 1959 the total saw log cut increased about 500 percent, but the cut on National Forest lands increased 3,000 percent. The more rapid increase of cutting on public lands reflects two things:

- The fact that wood industries have expanded beyond the capacity of private lands to produce wood.
- Progress made in opening up these public lands.

Production from the National Forests and other public lands will increase still further as the road system is extended and as the forestry effort is intensified. Between 1951 and 1961 approximately 3,120 miles of road were built on the Western Montana National Forests to make timber accessible. Money available for stand regeneration and cultural work in young stands on National Forests has substantially increased in recent years.

How much wood the public forests of Western Montana will contribute to industry in the future will depend upon how much this land is developed and how intensively it is managed. It will also depend somewhat on the demands made on public forests for other uses. About 71 percent of the timber production potential in Western Montana is on public lands.



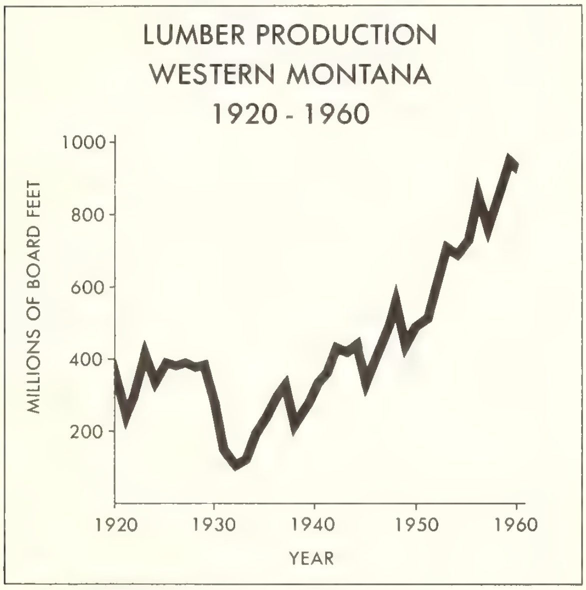
THE PLACE OF PUBLIC FOREST LAND IN WESTERN MONTANA

PUBLIC LANDS INCLUDE

- ▶ *77 percent of the total forest*
- ▶ *73 percent of the commercial forest*
- ▶ *97 percent of the noncommercial forest*
- ▶ *74 percent of the sawtimber volume*
- ▶ *53 percent of the sawtimber cut*
- ▶ *71 percent of the timber growth potential*

THE FOREST INDUSTRIES

In recent years the timber cut in Western Montana has reached an all time high. For example, the total cut in 1956 (the latest year for which complete data are available) was more than twice the cut in 1925 and about one-third greater than in 1948. Because about 93 percent of the timber cut is processed into lumber, data on lumber production generally indicate timber utilization. The upsurge in utilization is reflected by the chart below.


LUMBER PRODUCTION
WESTERN MONTANA
1920 - 1960

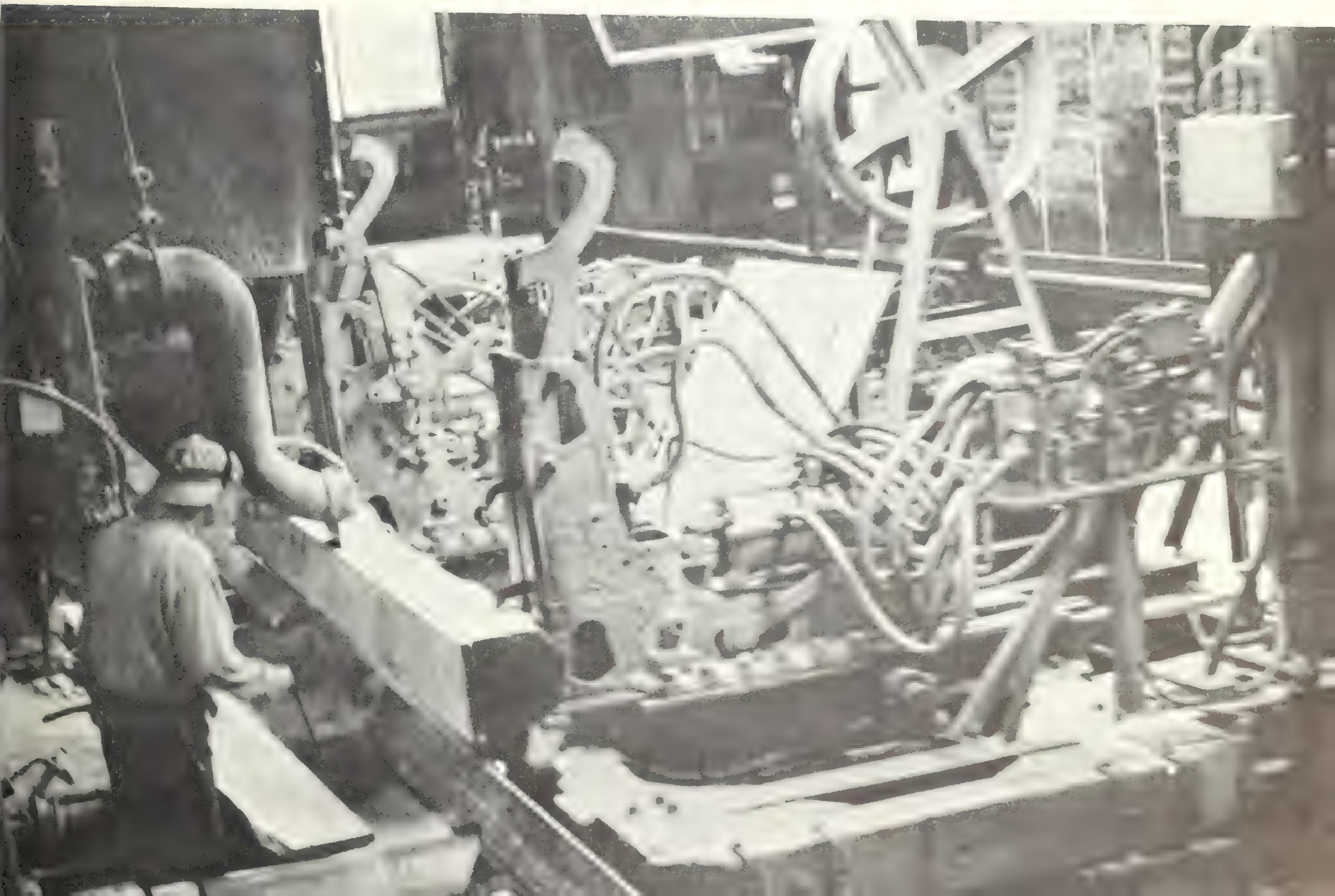
Accompanying the increase in production has been a 35 percent increase in employment between 1950 and 1960 (*1*). This increase in employment in wood industries has helped significantly in compensating for a concurrent statewide reduction of employment in agriculture and mining. It also contrasts sharply with an increase of only 4 percent in other manufacturing industries within the State during the same period.

The rise in lumber production from the depression low of the 1930's of less than 110 million board feet annually to the present level of about 900 million board feet has been paralleled by some striking shifts in the structure of the industry. Even within the last 10 years, there has been substantial change. Perhaps the most important development has been the swing away from the so-called "small" sawmill. Western Montana's early lumbering was by large mills because they alone had the efficiency to offset the high freight costs to the Middle West and East. Following World War II, there was an influx of small mills. In 1948, for example, 43 percent of the lumber was cut by sawmills producing less than 5 million board feet each, while 35 percent was cut by mills producing 10 million board feet or more. In 1956, the percentages had changed to 20 and 68, respectively. As profit margins have narrowed, many small mills have either grown into large mills or dropped out. Small mills, especially the 8-foot stud mills, can play an important role in processing small timber — either second growth, or the characteristically small lodgepole pine. Many of these mills survive mainly because they belong to companies also owning large mills, or are associated with concerns that market the ouput of several small mills. In general, large-scale operation appears to be a prerequisite for continuing competition as markets fluctuate. For example, data collected for the Clark Fork drainage of Western Montana in 1956 showed that sawmills producing 20 million board feet or more in that year all had planers and dry kilns. None of the sawmills producing less than 5 million board feet annually had dry kilns; only 25 percent had planers. Seventy-one percent of the large mill production was finished lumber; only 17 percent of the small mill production was finished lumber. The large mills operated year-round; the small ones less than half the year.

No doubt the increasing dominance of the large sawmills has been the result of their move toward full mechanization. For example, between 1955 and 1960 there is evidence that the cost of producing lumber in larger mills remained fairly constant, although wage rates rose about 16 percent.

Small Sawmill in Granite County. Photo: J. H. Wikstrom.

Headsaw in a large sawmill. Anaconda Forest Products, Inc., Bonner. Photo: Charles R. Lockard.



There has also been a longer time shift in the size and species composition of the lumber produced. For many years production ran heavily to ponderosa pine, which is most commonly sawed into 1-inch boards. In recent years, larch and Douglas-fir, primarily structural species, have made up the bulk of the lumber output.

	Percent of lumber production that was ponderosa pine
1940	46
1950	37
1960	11

Establishment of a pulpmill near Missoula has been a big step forward in wood utilization. Raw material for the present plant is sawmill residue. A substantial further expansion of pulpmill capacity would be possible, using timber not suitable for lumber. Western Montana has at least 75 million cords of such roundwood suitable for pulping. Much of this wood is in mature but pole-size lodgepole pine trees. The rest is in cull and small trees in sawtimber stands. This timber has not been attractive to pulpmills because the cost of utilization is high. The problem has been to reduce these costs. Experiments in field debarking and chipping and pipeline transportation of chips may help open the way to further expansion of the pulp industry.

This part of the State is blessed with an abundance of good quality water as well as a lot of wood. In 1955 the U.S. Public Health Service and the Montana Board of Health (*6*) surveyed Western Montana streams, rating their capacity to handle pulpmill waste or effluent. The survey report recommended six presently unused stretches of river and suggested the kraft mill capacity that each river could tolerate.

	Kraft mill capacity at undeveloped pulpmill sites Tons of pulp per day
Clark Fork River — St. Regis to junction with Flathead River	300
Clark Fork River below Plains, Montana	1,000
Flathead River — South Fork to Flathead Lake	200
Flathead River — Flathead Lake to junction with Clark Fork	400
Kootenai River — above Libby, Montana	300
Kootenai River — below Libby, Montana	400

If per-ton waste is reduced or treated beyond the standards assumed in the millsite survey, additional pulping capacity would be available; that is, larger mills could be established at the sites listed above, and certain additional sites would be suitable. For example, although the plant of the Waldorf-Hoerner Paper Products Company at Missoula considerably exceeds the capacity once recommended at that point, the increased capacity was approved by the State because improved design reduced the per-ton waste load.

Another bright spot in Western Montana's timber development has been the construction of five plywood plants in the last 10 years. Plywood plants also provide important diversification as they offer a market for top quality logs. Western Montana has 30,869 million board feet in trees 21 inches and larger. Twenty-seven percent is larch, a proven plywood species. Plywood plants provide an opportunity to get high revenue from this timber. Other species also offer plywood opportunities.

Utilization of larch is expected to increase further as a result of a recently developed commercial process for extracting industrial gum (arabinogalactan). The gum, which has demonstrated important advantages over gum arabic for lithography and other purposes, is being produced at a prototype plant operated by the J. Neils Lumber Company Division of St. Regis Paper Company at Libby. Here sawmill and plywood mill residues provide the raw materials for gum extraction. The fact that the chips are still suitable for pulp making after extraction of gum is a notable event in the trend toward more complete use of the tree.

Some of the 175,000 tons of chips in storage at Waldorf-Hoerner Paper Products Company, Missoula. This plant employs about 220 people. It subsists entirely on sawmill residue and provides a market for chips from slabs and edgings of sawmills as far away as 300 miles. Photo: Charles R. Lockard.

Glue spreading, Van-Evan Plywood Company, Missoula. Photo: Charles R. Lockard.

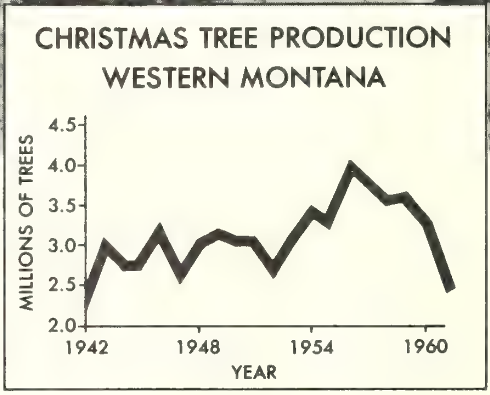
PHOTO. Ben M. Huey

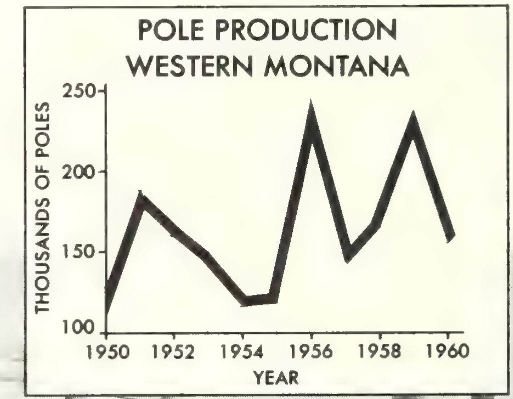
These two photos — a Christmas tree yard at Missoula and the Montana Pole Company yard at Butte — show two other Montana forest products.

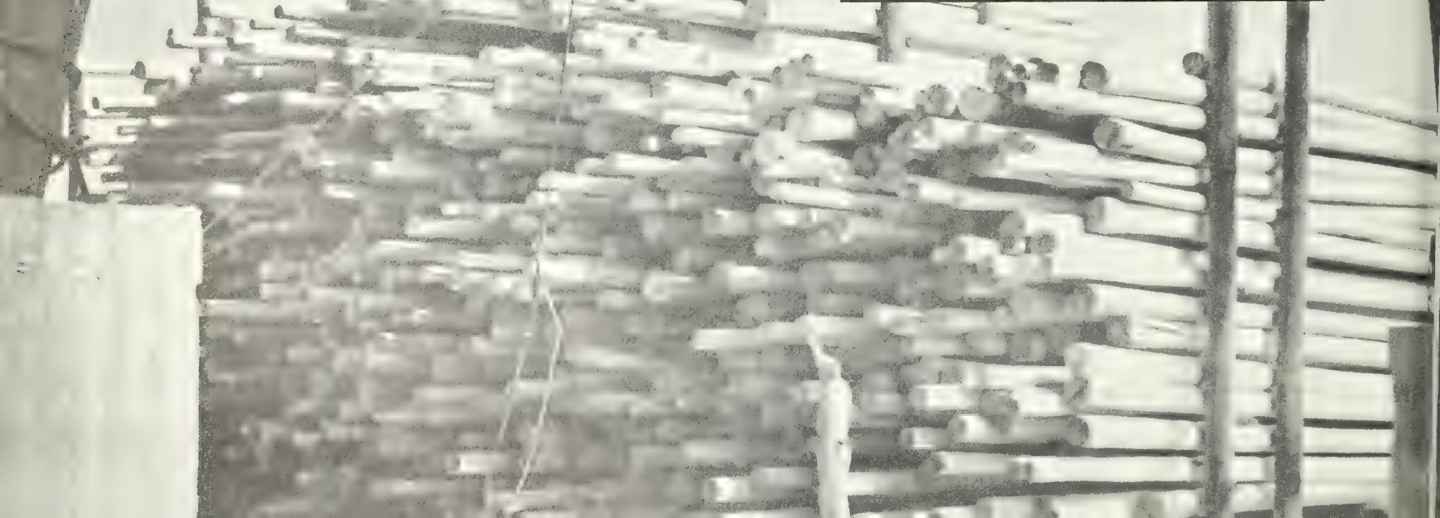
Western Montana, one of the main Christmas tree producing areas in the United States, has an estimated potential of 5 million trees a year on a sustained basis.

Wide fluctuations in pole production reflect an erratic market. Between 1950 and 1960 the number of poles produced in Western Montana ranged between 116,000 and 244,000 a year.

PHOTO: Charles R. Lockard







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APPENDIX

TERMINOLOGY

Forest Land

The term *forest land* includes (a) land which is at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking, and which has not been developed for other use; (c) afforested areas.

At the time the fieldwork for this report was performed, the minimum unit of area for forest land classification was 10 acres with a minimum width of stringer strips of 120 feet.

The principal classes of forest land are:

Commercial forest land. — Forest land which is (a) producing, or is physically capable of producing, usable crops of wood (usually sawtimber), (b) economically available now or prospectively, and (c) not withdrawn from timber utilization.

Noncommercial forest land. — Three classes of noncommercial forest land are recognized: *Productive-reserved*, *Unproductive-nonreserved*, and *Unproductive-reserved.*

Productive-reserved is public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

Unproductive indicates forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions, or forest land so physically inaccessible as to be unavailable economically in the forseeable future.

Forest Types

Forest land is classified into types on the basis of tree species; the type name is that of the predominant species. The predominant species is the one which has a plurality of (a) gross cubic volume in the case of sawtimber and poletimber stands, or (b) the number of stems in seedling and sapling stands. Both growing stock and cull trees are considered in the classification. Forest types which occur on both commercial and noncommercial forest land are:

Douglas-fir
Ponderosa pine
Western white pine
Lodgepole pine
White bark and limber pine
White fir
Grand fir
Subalpine fir
Engelmann spruce
Mountain hemlock
Western hemlock
Western redcedar
Western larch
Aspen
Cottonwood
Other western hardwoods

Two additional forest types which occur only on noncommercial forest land are:

Pinyon-juniper
Chaparral

Tree-Size Classes

Sawtimber-size tree

A tree 11.0 inches d.b.h. or larger.

Pole-size tree

A tree 5.0 to 10.9 inches d.b.h.

Seedling-sapling trees

Trees at least 1 foot high and less than 5.0 inches d.b.h.

Tree-Merchantability Classes

Sawtimber tree

Live tree of commercial species, 11.0 inches d.b.h. or larger, that contains at least one 10-foot log to a merchantable top diameter and having the likelihood of eventually containing at least a 16-foot minimum saw log. Also, at least one-third of the board-foot volume must be free from rot or other defect.

Poletimber tree

Live tree of commercial species, 5.0 to 10.9 inches d.b.h., free of rot and having the likelihood of growing into a sawtimber tree.

Sapling and seedling trees

Live trees of commercial species, less than 5.0 inches d.b.h., with form and quality to qualify as potential poletimber trees.

Growing stock trees

Sawtimber trees, poletimber trees, saplings and seedlings; i.e., all live trees except cull trees.

In discussion and tables on volumes, growth, and mortality, the term *growing stock* refers only to sawtimber trees and poletimber trees; i.e., all live trees 5 inches d.b.h. and larger (except cull trees). Saplings and seedlings are not part of growing stock in this usage of the term.

Cull tree

Live tree of sawtimber- or poletimber-size that is unmerchantable for saw logs, now or prospectively, because of rot or other defect, or species.

Sound cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull with at least one-half of this cull the result of sweep, crook, or other sound defect. Also included are sound trees which do not contain at least one 10-foot saw log.

b. Poletimber-size trees that are unlikely to grow into sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, crooks or girdling by porcupine. No rot may be present.

Rotten cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull, with more than half of the cull due to rot.

b. Poletimber-size trees showing any evidence of rot in the main stem.

Mortality tree

A tree 5.0 inches d.b.h. or larger, standing or down, which has died within the past 5 years and was not a cull tree at time of death.

Salvable dead tree

Dead tree 5.0 inches d.b.h. or larger, standing or down (but not lying on the ground) which has 50 percent or more of its cubic-foot volume in sound wood.

Stand-Size Classes

Sawtimber stands

A stand with a minimum net volume per acre of 1,500 board feet (International ¼-inch rule) in sawtimber trees. Two classes of sawtimber stands are recognized:

Large sawtimber. A stand in which the majority of the net board-foot volume is in sawtimber trees 21.0 inches d.b.h. and larger.

Small sawtimber. A stand in which the majority of the net board-foot volume is in sawtimber trees from 11.0 to 20.9 inches d.b.h.

Poletimber stand

Stand failing to meet the sawtimber stand specifications, but at least 10 percent stocked with poletimber and larger

(5.0 inches d.b.h. and larger) trees and with at least half the minimum stocking in poletimber trees.

Seedling and sapling stand

A stand not qualifying as either a sawtimber or poletimber stand, but having at least 10 percent stocking of trees of commercial species and with at least half the stocking in seedling and sapling trees.

Nonstocked area

An area not qualifying as a sawtimber, poletimber, or a seedling-sapling stand; i.e., normally an area less than 10 percent stocked.

Stocking

Stocking is a measure of the degree to which growing space is effectively utilized by trees. In this report it is expressed as the percentage of the available space that is occupied by tree crowns as viewed on aerial photographs.

Well-stocked stand

A stand that is 70 percent or more covered by tree crowns.

Medium-stocked stand

A stand with 40 to 70 percent coverage by tree crowns.

Poorly stocked stand

A stand with 10 to 40 percent coverage by tree crowns.

Nonstocked area

An area with less than 10 percent coverage by tree crowns.

Timber Volume

All-timber volume

Volume in cubic feet of sound wood in the bole of growing stock, cull and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top inside bark.

Growing stock volume

Net volume in cubic feet of sawtimber trees and poletimber trees from stump to a minimum 4.0-inch top inside bark.

Live sawtimber volume

Net volume in board feet, International ¼-inch rule, of the saw log portion of sawtimber trees.

Saw log portion

That portion of the bole of sawtimber trees between the stump and the merchantable top.

Merchantable top

The point at which the upper limit of saw log merchantability is limited either by limbs or by a minimum diameter. The latter varies with diameter class ranging from 5 inches inside bark for trees 11 inches at breast height to 10 inches for trees 26 inches or larger.

Upper-stem portion

That part of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches inside bark.

Quality class

A classification of sawtimber volume in terms of log grades. Four grades are recognized and distinguished by the occurrence and characteristics of knots. The log grades corresponding to the quality classes are:

Grade 1 (select logs) are essentially smooth and surface clear, except that in logs 16 inches and larger in diameter a few visible knots are permitted, provided there are no more than 1 large knot, or 2 medium or small knots, or 4 pin knots.

Knot sizes for all grades are:

Pin knots	0.5 inch or less
Small knots	0.5 to 0.75 inch
Medium knots	0.75 to 1.5 inches
Large knots	Larger than 1.5 inches

Occasional logs having a greater number of knots are admitted provided these knots may be boxed in an area not exceeding one-third the area of one face or an equivalent area of two faces.

Grade 2 (shop logs) display relatively few knots of any size, so spaced that at least 50 percent of the surface of the log is in smooth, clear areas, the size of which must be at least one-fourth the girth of the log in width, by 4 feet or more in length.

A log with no more than 12 medium or smaller knots, or more than 8 large ones, may immediately be classed as grade 2. If this number of knots is exceeded, the clear area basis governs.

Grade 3 (common logs) display either (a) pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab, or (b) 16 dead knots (an average of 4 per face) averaging medium in size.

Grade 4 (low common logs) display medium, large, and very large live and/or dead knots in excess of the numbers permitted in grades 2 and 3.

Growth

Net annual growth of sawtimber or growing stock

The average annual change, calculated from the total change over a 10-year period, in net board-foot or cubic-foot volume of live sawtimber or growing stock on commercial forest land.

Mortality

Net annual mortality of sawtimber or growing stock

The average annual net board-foot or cubic-foot volume removed from live sawtimber or growing stock through death, calculated from the total net volume removed by such causes over a 10-year period.

Timber Cut

Timber cut from growing stock

The volume of sound wood in live sawtimber and poletimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Timber cut from sawtimber

The net board-foot volume of live sawtimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Logging residues from growing stock

The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging on commercial forest land and not converted to timber products.

Ownership Classes

National Forest lands

Federal lands which have been designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Other Federal lands

Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies.

State, county, and municipal lands

Lands owned by State, counties, and local public agencies, or lands leased by these governmental units more than 50 years ago.

Forest industry lands

Lands owned by companies or individuals operating wood-using plants.

Farmer-owned lands

Lands owned by operators of farms.

Miscellaneous private lands

Privately owned lands other than forest-industry or farmer-owned lands.

Principal Tree Species

Softwoods

Douglas-fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Fir, grand	*A. grandis*
Fir, white	*A. concolor*
Hemlock, mountain	*Tsuga mertensiana*
Hemlock, western	*T. heterophylla*
Juniper	*Juniperus* spp.
Larch, alpine	*Larix lyalli*
Larch, western	*L. occidentalis*
Pine, limber	*Pinus flexilis*
Pine, lodgepole	*P. contorta*
Pine, ponderosa	*P. ponderosa*
Pine, western white	*P. monticola*
Pine, whitebark	*P. albicaulis*
Redcedar, western	*Thuja plicata*
Spruce, Engelmann	*Picea engelmannii*

Hardwoods

Aspen, quaking	*Populus tremuloides*
Cottonwood, black	*P. trichocarpa*
Birch, paper	*Betula papyrifera*

SURVEY METHODS

Area statistics were determined by mapping. About 20 percent of the survey area was completely mapped; for the remainder, mapping was done only on sample sections located at 4-mile intervals in a rectangular grid pattern. In both cases mapping was done on aerial photographs and subsequently field checked. Delineations segregated nonforest from forest land, noncommercial from commercial forest, and classified commercial forest by timber type, stand size, and stand density. Areas were classified to a minimum area of 10 acres. Ownership classes were also outlined. Area of the various cover classes by ownerships was determined by dot counts which were then summarized and, in the case of sample areas, multiplied by appropriate factors to give total area.

Volume statistics were derived from field samples taken at 4-mile intervals on the rectangular grid mentioned above. Plots were taken in the immediate vicinity of the section corners designated by the grid. In the area which had been mapped on a sampling basis plots fell within the mapped sections.

Samples were taken at 1,172 locations in Western Montana. Each sample consisted of two plots, spaced 5 chains apart. If necessary the predetermined compass bearing from the first to the second plot was altered to insure that both plots fell in the same type-size-density stratum. Each plot consisted of four concentric circular subplots. Seedlings and saplings were tallied an 1/500 acre, poles on 1/50 acre, sawtimber on 1/5 acre, and mortality on 1/3 acre.

In addition to making the customary measurements and classifications of trees for volume and quality, increment borings were taken for growth estimates.

Formulas equating field measurements to volume, growth, and mortality were applied as part of the machine data processing to provide average volumes per acre for the various classifications based on type, size, stocking, etc. These averages, applied to area estimates, provided the total volumes used in statistical tables.

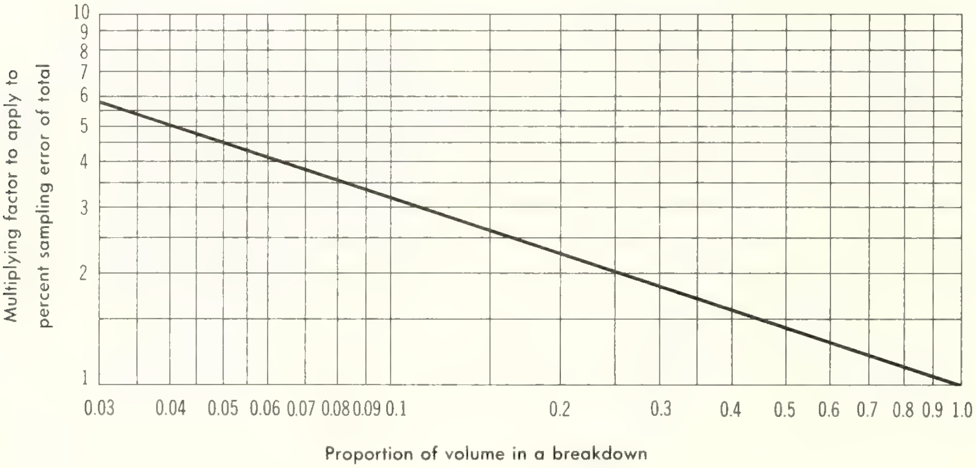
Timber-cut estimates in some cases are based on output data for a single year when that year is considered typical of the period during which the survey was conducted. In other instances primary product output and logging residue figures are averages based on periodic surveys of the forest industries. Lumber industry surveys, conducted in cooperation with the Bureau of the Census, provide lumber production and log receipts data for estimating the predominant part of the cut. Periodic surveys are also conducted to determine the output of pulpwood, commercial poles, fuelwood, mine timbers, posts, and miscellaneous timbers of lesser importance. Data for estimating the volume of logging residues are obtained by special studies on active woods operations.

RELIABILITY OF ESTIMATES

Data collected by sampling are not entirely reliable; i.e., there is a sampling error. Sufficient samples are taken to insure that the error is not above a specified maximum. Magnitude of the errors associated with area and volume estimates for Western Montana have been determined by statistical analysis of the data.

Estimates of acreage of the various land and forest classes were determined by sampling on about 84 percent of Western Montana and compilation from type maps on the remainder. For the sampled portion the sampling error of the estimate of commerical forest area is ±1.83 percent, and of noncommercial forest ±11.48 percent. These errors are on the basis of odds of two out of three that values which would result from a 100-percent cruise would lie within the range indicated by the error. There is no sampling error for the area which was completely mapped.

The sampling error for the estimated 19,541 million cubic feet of growing stock in Western Montana is ±2.42 percent. The sampling error for estimates other than total volume can be roughly approximated by using the following chart:



Ratio of sampling error of a volume breakdown
to sampling error of total area or volume.

As an example of the use of the chart, assume that the sampling error reported for a total is ±5 percent. An estimate is desired of the sampling error for an item which is only 0.25 of this total. Reading from the chart, the multiplying factor for a proportion of 0.25 is 2. The estimated sampling error for the item is then 2 times ±5 percent, or ±10 percent.

APPENDIX TABLES

Table 1.—**Area by land classes, Western Montana, 1958**

Land class	Thousand acres
Commercial forest land	10,453
Noncommercial forest land:	
Unproductive-nonreserved	598
Productive-reserved	889
Unproductive-reserved	768
Total forest land	12,708
Nonforest land	[1]3,266
Total, all land	[2]15,974

[1] Includes 95,000 acres of water according to Survey standards of area classification but defined by Bureau of Census as land.

[2] From U. S. Bureau of the Census, Land and Water Areas of the United States, 1950.

Table 2.—**Area of commercial forest land, by ownership classes, Western Montana, 1958**

Ownership class	Thousand acres
National Forest	6,680
Other Federal:	
Bureau of Land Management	156
Indian	373
Miscellaneous Federal	3
Total other Federal	532
State	439
County and municipal	2
Forest industry:	
Pulp and paper	—
Lumber	1,047
Other	—
Total forest industry	1,047
Farmer-owned	471
Miscellaneous private	1,282
All ownerships	10,453

Table 3.—**Area of commercial forest land, by stand-size and ownership classes, Western Montana, 1958**

Stand-size class	All ownerships	National Forest	Other public	Forest industry	Farmer and misc. private
	Thousand acres				
Sawtimber stands:					
Large sawtimber	1,595	998	102	355	140
Small sawtimber	4,730	2,788	553	468	921
Total	6,325	3,786	655	823	1,061
Poletimber stands	2,937	1,973	232	178	554
Sapling and seedling stands	1,018	788	76	35	119
Nonstocked area	173	133	10	11	19
All classes	10,453	6,680	973	1,047	1,753

Table 4.—**Area of commercial forest land, by stocking classes of all live trees and by stand-size classes, Western Montana, 1958**

Stocking class (all trees)	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Non-stocked stands
	Thousand acres				
70 percent or more	5,730	3,674	1,426	630	—
40 to 70 percent	3,366	2,106	1,032	228	—
10 to 40 percent	1,184	545	479	160	—
Less than 10 percent	173	—	—	—	173
All classes	10,453	6,325	2,937	1,018	173

Table 5.—**Area of commercial forest land, by types and ownership classes, Western Montana, 1958**

Type	All ownerships	Public ownerships	Private ownerships
	Thousand acres		
Douglas-fir	2,837	1,926	911
Ponderosa pine	1,668	852	816
White pine[1]	181	160	21
Lodgepole pine[2]	2,850	2,374	476
Fir-spruce	896	831	65
Hemlock[3]	33	29	4
Larch	1,939	1,474	465
Hardwoods	49	7	42
All types	10,453	7,653	2,800

[1] Includes 35,000 acres of western redcedar type.

[2] Includes 104,000 acres of whitebark and limber pine type.

[3] Includes 6,000 acres of mountain hemlock.

Table 6.—**Number of growing-stock trees on commercial forest land, by diameter classes and by softwoods and hardwoods, Western Montana, 1958**

D.B.H. class (inches)	All species	Softwood	Hardwood
	Thousand trees		
1.0 to 2.9	7,285,560	7,238,621	46,939
3.0 to 4.9	2,074,365	2,061,869	12,496
5.0 to 6.9	830,351	826,240	4,111
7.0 to 8.9	430,663	429,086	1,577
9.0 to 10.9	237,892	237,670	222
11.0 to 12.9	119,822	119,446	376
13.0 to 14.9	76,645	76,370	275
15.0 to 16.9	51,409	51,183	226
17.0 to 18.9	34,645	34,507	138
19.0 to 28.9	61,195	61,026	169
29.0 to 38.9	6,640	6,640	—
39.0 and larger	532	532	—
Total	11,209,719	11,143,190	66,529

Table 7.—**Number of cull and salvable dead trees on commercial forest land, by diameter groups and by softwoods and hardwoods, Western Montana, 1958**

D.B.H. class (inches)	Cull trees			Salvable dead trees
	Total	Sound	Rotten	
	Thousand trees			
Softwoods:				
5.0 to 8.9	94,624	49,972	44,652	73,518
9.0 to 18.9	31,036	11,335	19,701	59,568
19.0 and larger	2,680	102	2,578	6,325
Total	128,340	61,409	66,931	139,411
Hardwoods:				
5.0 to 10.9	3,393	1,131	2,262	19
11.0 to 18.9	450	324	126	—
19.0 and larger	415	233	182	—
Total	4,258	1,688	2,570	19
All species	132,598	63,097	69,501	139,430

Table 8.—**Volume of timber on commercial forest land, by class of timber and by softwoods and hardwoods, Western Montana, 1958**

Class of timber	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Sawtimber trees:			
Saw log portion	11,589,751	11,557,217	32,534
Upper-stem portion	925,200	916,055	9,145
Total	12,514,951	12,473,272	41,679
Poletimber trees	7,025,665	6,998,906	26,759
All growing-stock trees	19,540,616	19,472,178	68,438
Sound cull trees:			
Sawtimber-size trees	68,089	55,803	12,286
Poletimber-size trees	200,300	197,551	2,749
Total	268,389	253,354	15,035
Rotten cull trees:			
Sawtimber-size trees	101,687	98,758	2,929
Poletimber-size trees	161,704	159,709	1,995
Total	263,391	258,467	4,924
Salvable dead trees:			
Sawtimber-size trees	1,599,848	1,598,890	958
Poletimber-size trees	673,200	672,976	224
Total	2,273,048	2,271,866	1,182
All timber	22,345,444	22,255,865	89,579

Table 9.—**Volume of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Western Montana, 1958**

Ownership class	All species	Softwoods	Hardwoods
	GROWING STOCK *(Million cubic feet)*		
National Forest	13,056	13,034	22
Other public	1,590	1,584	6
Forest industry	2,155	2,149	6
Farmer and misc. private	2,740	2,706	34
All ownerships	19,541	19,473	68
	SAWTIMBER *(Million board feet)*[1]		
National Forest	48,596	48,542	54
Other public	5,716	5,689	27
Forest industry	9,440	9,419	21
Farmer and misc. private	9,702	9,597	105
All ownerships	73,454	73,247	207

[1] International ¼-inch rule.

Table 10.—**Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, Western Montana, 1958**

Stand-size class	All species	Softwoods	Hardwoods
	GROWING STOCK *(Million cubic feet)*		
Sawtimber stands	15,143	15,095	48
Poletimber stands	3,945	3,927	18
Sapling and seedling stands	418	416	2
Nonstocked areas	35	35	([1])
Total	19,541	19,473	68
	SAWTIMBER *(Million board feet)*[2]		
Sawtimber stands	68,691	68,498	193
Poletimber stands	3,890	3,880	10
Sapling and seedling stands	798	794	4
Nonstocked areas	75	75	([1])
Total	73,454	73,247	207

[1] Less than 0.5 million feet.

[2] International ¼-inch rule.

Table 11.—**Volume of growing stock on commercial forest land, by species and diameter groups, Western Montana, 1958**

Species	All classes	5.0 to 10.9	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million cubic feet					
Softwoods:						
Douglas-fir	5,429	1,375	2,732	1,135	159	28
Ponderosa pine	1,949	192	800	741	206	10
White pine	320	55	176	74	8	7
Lodgepole pine	4,346	3,515	819	12	—	—
True firs[1]	1,428	815	539	71	3	—
Spruce	2,261	369	993	670	218	11
Western hemlock	165	39	87	25	14	—
Western redcedar	412	96	112	114	51	39
Western larch[2]	2,896	448	1,161	1,024	254	9
Other softwoods	267	95	148	24	—	—
Total	19,473	6,999	7,567	3,890	913	104
Hardwoods:						
Aspen and cottonwood	54	16	27	11	—	—
Other hardwoods	14	11	3	—	—	—
Total	68	27	30	11	—	—
All species	19,541	7,026	7,597	3,901	913	104

Diameter class (inches at breast height) applies to all columns after Species.

[1] White, grand, and subalpine firs.

[2] Includes a negligible amount of alpine larch.

Table 12.—**Volume of sawtimber on commercial forest land, by species and diameter groups, Western Montana, 1958**

Species	All classes	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million board feet[1]				
Softwoods:					
Douglas-fir	22,970	14,841	6,973	980	176
Ponderosa pine	10,498	4,425	4,598	1,402	73
White pine	1,547	1,019	440	50	38
Lodgepole pine	4,648	4,577	71	—	—
True firs[2]	3,427	2,984	423	20	—
Spruce	11,393	5,717	4,174	1,432	70
Western hemlock	727	489	153	85	—
Western redcedar	1,712	593	649	279	191
Western larch[3]	15,379	6,979	6,716	1,626	58
Other softwoods	946	807	139	—	—
Total	73,247	42,431	24,336	5,874	606
Hardwoods:					
Aspen and cottonwood	188	135	53	—	—
Other hardwoods	19	19	—	—	—
Total	207	154	53	—	—
All species	73,454	42,585	24,389	5,874	606

[1] International ¼-inch rule.

[2] White, grand, and subalpine firs.

[3] Includes a negligible amount of alpine larch.

Table 13.—Volume of sawtimber on commercial forest land, by species and diameter groups, Western Montana, 1958

Species	Diameter class (inches at breast height)				
	All classes	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million board feet[1]				
Softwoods:					
Douglas-fir	19,767	12,475	6,224	901	167
Ponderosa pine	9,073	3,647	4,073	1,285	68
White pine	1,355	880	394	46	35
Lodgepole pine	3,850	3,787	63	—	—
True firs[2]	2,923	2,526	379	18	—
Spruce	10,263	5,126	3,774	1,298	65
Western hemlock	633	417	138	78	—
Western redcedar	1,455	481	551	245	178
Western larch[3]	13,309	5,713	6,046	1,495	55
Other softwoods	803	679	124	—	—
Total	63,431	35,731	21,766	5,366	568
Hardwoods:					
Aspen and cottonwood	179	128	51	—	—
Other hardwoods	16	16	—	—	—
Total	195	144	51	—	—
All species	63,626	35,875	21,817	5,366	568

[1] Scribner rule.
[2] White, grand, and subalpine firs.
[3] Includes a negligible amount of alpine larch.

Table 14.—Volume of sawtimber on commercial forest land, by softwood species and quality classes, Western Montana, 1958

Species	Quality class (log grade)				
	All classes	1	2	3	4
	Million board feet[1]				
Softwoods:					
Douglas-fir	22,970	1,204	3,766	7,086	10,914
Ponderosa pine	10,498	2,245	1,629	2,146	4,478
White pine	1,547	581	292	411	263
True firs[2]	3,427	41	125	1,327	1,934
Spruce	11,393	414	1,221	4,914	4,844
Western hemlock	727	9	11	210	497
Western larch[3]	15,379	5,346	3,468	3,047	3,518
Other softwoods	7,306	313	1,349	2,395	3,249
Total	73,247	10,153	11,861	21,536	29,697

[1] International ¼-inch rule.
[2] White, grand, and subalpine firs.
[3] Includes a negligible amount of alpine larch.

Table 15.—**Volume of salvable dead sawtimber-size trees on commercial forest land by softwoods and hardwoods, Western Montana, 1958**

Species group	Volume (thousand board feet)	
	International ¼-inch rule	Scribner rule
Softwoods	9,334,989	8,061,849
Hardwoods	4,828	4,148
All species	9,339,817	8,065,997

Table 16.—**Net annual growth and annual cut of growing stock on commercial forest land, by species, Western Montana**

Species	Net annual growth, 1958	Annual timber cut, 1956
	Thousand cubic feet	
Softwoods:		
Douglas-fir	84,330	37,539
Ponderosa pine	27,651	28,395
Western white pine	6,698	3,553
Lodgepole pine	100,562	4,362
True firs[1]	28,193	1,436
Engelmann spruce	2,313	26,540
Western hemlock	4,485	104
Western larch	25,404	27,978
Other softwoods	10,051	366
Total	289,687	130,273
Hardwoods	2,078	397
All species	291,765	130,670

[1] White, grand, and subalpine firs.

Table 17.—**Net annual growth and annual cut of growing stock on commercial forest land, by ownership classes and by softwoods and hardwoods, Western Montana**

Species group	All ownerships	National Forest	Other public	Forest industry	Farmer and misc. private
	NET ANNUAL GROWTH, 1958 (Thousand cubic feet)				
Softwoods	289,687	182,368	27,425	28,360	51,534
Hardwoods	2,078	668	195	208	1,007
All species	291,765	183,036	27,620	28,568	52,541
	ANNUAL TIMBER CUT, 1956 (Thousand cubic feet)				
Softwoods	130,273	59,068		[1]71,205	
Hardwoods	397	0		[1]397	
All species	130,670	59,068		[1]71,602	

[1] Includes "other public," "forest industry," and "farmer and miscellaneous private."

Table 18.—**Net annual growth and cut of sawtimber on commercial forest land, by species, Western Montana**

Species	Net annual growth, 1958	Annual timber cut, 1956
	Thousand board feet[1]	
Softwoods:		
Douglas-fir	296,982	254,669
Ponderosa pine	142,883	193,467
Western white pine	30,719	24,339
Lodgepole pine	84,768	27,980
True firs[2]	55,292	9,860
Engelmann spruce	–40,843	181,742
Western hemlock	20,159	622
Western larch	84,719	190,890
Other softwoods	40,950	2,398
Total	715,629	885,967
Hardwoods	4,803	2,360
All species	720,432	888,327

[1] International ¼-inch rule.

[2] White, grand, and subalpine firs.

Table 19.—**Net annual growth and cut of sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Western Montana**

Species group	All ownerships	National Forest	Other public	Forest industry	Farmer and misc. private
		NET ANNUAL GROWTH, 1958 (Thousand board feet)[1]			
Softwoods	715,629	403,757	83,046	85,367	143,459
Hardwoods	4,803	1,849	637	600	1,717
All species	720,432	405,606	83,683	85,967	145,176
		ANNUAL TIMBER CUT, 1956 (Thousand board feet)[1]			
Softwoods	885,967	401,524		[2]484,443	
Hardwoods	2,360	0		[2]2,360	
All species	888,327	401,524		[2]486,803	

[1] International ¼-inch rule.

[2] Includes "other public," "forest industry," and "farmer and miscellaneous private."

Table 20. — **Annual mortality of growing stock and sawtimber on commercial forest land, by species, Western Montana, 1958**

Species	Growing stock	Sawtimber
	Thousand cubic feet	*Thousand board feet*[1]
Softwoods:		
Douglas-fir	20,426	103,915
Ponderosa pine	6,572	39,228
White pine	733	3,164
Lodgepole pine	17,652	42,980
True firs[2]	9,510	36,670
Spruce	36,678	225,384
Western hemlock	290	508
Western larch	11,646	69,510
Other softwoods	855	2,989
Total	104,362	524,348
Hardwoods	46	—
All species	104,408	524,348

[1] International ¼-inch rule.

[2] White, grand, and subalpine firs.

Table 21.—**Annual mortality of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Western Montana, 1958**

Ownership	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Thousand cubic feet			*Thousand board feet*[1]		
National Forest lands	74,427	74,426	1	373,991	373,991	—
Other public lands	6,745	6,742	3	33,826	33,826	—
Forest industry lands	12,879	12,877	2	67,638	67,638	—
Farmer and misc. private lands	10,357	10,317	40	48,893	48,893	—
Total, all ownerships	104,408	104,362	46	524,348	524,348	—

[1] International ¼-inch rule.

Table 22.—**Annual mortality of growing stock and sawtimber on commercial forest land by causes, and by softwoods and hardwoods, Western Montana, 1958**

Cause of death	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Thousand cubic feet			*Thousand board feet*[1]		
Fire	1,291	1,291	—	5,610	5,610	—
Insects	57,319	57,319	—	311,865	311,865	—
Disease	5,493	5,451	42	28,983	28,983	—
Other	40,305	40,301	4	177,890	177,890	—
All causes	104,408	104,362	46	524,348	524,348	—

[1] International ¼-inch rule.

Table 23.—**Total ouput of timber products, by products, by type of material used, and by softwoods and hardwoods, Western Montana, 1956**

Product and species group	Total output in standard units		Output from roundwood from growing stock		Output from roundwood from nongrowing stock sources		Output from plant by-products (standard units)
	Unit	Number	Standard units	M cubic feet	Standard units	M cubic feet	
Saw logs:[1]							
Softwood	M bd.-ft.[2]	1,055,783	807,280	115,326	[3]248,503	35,500	0
Hardwood	M bd.-ft[2]	2,147	2,147	307	0	0	0
Total	M bd.-ft.[2]	1,057,930	809,427	115,633	248,503	35,500	0
Pulpwood:							
Softwood	M std. cords[4]	35	1	81	[3]34	2,241	0
Hardwood	M std. cords[4]	(5)	(5)	12	0	0	0
Total	M std. cords[4]	35	1	93	34	2,241	0
Poles:							
Softwood	M pieces	244	244	2,378	0	0	0
Hardwood	M pieces	0	0	0	0	0	0
Total	M pieces	244	244	2,378	0	0	0
Mine timbers (round):							
Softwood	M cu. ft.	4,996	4,746	4,746	250	250	0
Hardwood	M cu. ft.	0	0	0	0	0	0
Total	M cu. ft.	4,996	4,746	4,746	250	250	0
Misc. industrial wood:[6]							
Softwood	M cu. ft.	244	244	244	0	0	0
Hardwood	M cu. ft.	0	0	0	0	0	0
Total	M cu. ft.	244	244	244	0	0	0
Posts (round and split):							
Softwood	M pieces	763	565	452	198	158	0
Hardwood	M pieces	0	0	0	0	0	0
Total	M pieces	763	565	452	198	158	0
Fuelwood:							
Softwood	M std. cords[4]	511	9	704	129	9,967	373
Hardwood	M std. cords[4]	48	1	62	12	881	35
Total	M std. cords[4]	559	10	766	141	10,848	408
Misc. farm timbers:							
Softwood	M cu. ft.	397	327	327	70	70	0
Hardwood	M cu. ft.	0	0	0	0	0	0
Total	M cu. ft.	397	327	327	70	70	0
All products:							
Softwood	M cu. ft.	—	—	124,258	—	48,186	—
Hardwood	M cu. ft.	—	—	381	—	881	—
Total	M cu. ft.	—	—	124,639	—	49,067	—

---

[1] Includes veneer logs and bolts.

[2] International ¼-inch log rule.

[3] Largely from dead timber salvaged in the spruce salvage project (to salvage beetle-killed spruce) that was started in 1952 and continued for several years.

[4] Rough wood basis.

[5] Less than 0.5 M standard cords.

[6] Includes shingle bolts, house logs, converter poles.

Table 24.—**Total output of roundwood products, by source and by softwoods and hardwoods, Western Montana, 1956**

Source	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Growing-stock trees:[1]			
Sawtimber trees	120,601	120,282	319
Poletimber trees	4,038	3,976	62
Total	124,639	124,258	381
Cull trees[1]	47	47	0
Salvable dead trees[1]	[3]47,380	[3]47,380	0
Other sources[2]	1,640	759	881
All sources	173,706	172,444	1,262

[1] On commercial forest land.

[2] Includes noncommercial forest land, nonforest land such as fence rows, trees less than 5.0 inches in diameter, and treetops and limbs.

[3] Largely from dead sawtimber trees salvaged in the spruce salvage project.

Table 25.—**Annual timber cut from growing stock on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Western Montana, 1956**

Products and residues	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Roundwood products:			
Saw logs	115,633	115,326	307
Veneer logs and bolts	(1)	(1)	(1)
Cooperage logs and bolts	0	0	0
Pulpwood	93	81	12
Piling	(2)	(2)	(2)
Poles	2,378	2,378	0
Mine timbers	4,746	4,746	0
Misc. industrial wood[3]	571	571	0
Posts	452	452	0
Fuelwood	766	704	62
All products	124,639	124,258	381
Logging residues	6,031	6,015	16
Timber cut	130,670	130,273	397

[1] Included with saw logs to avoid disclosing individual operations.

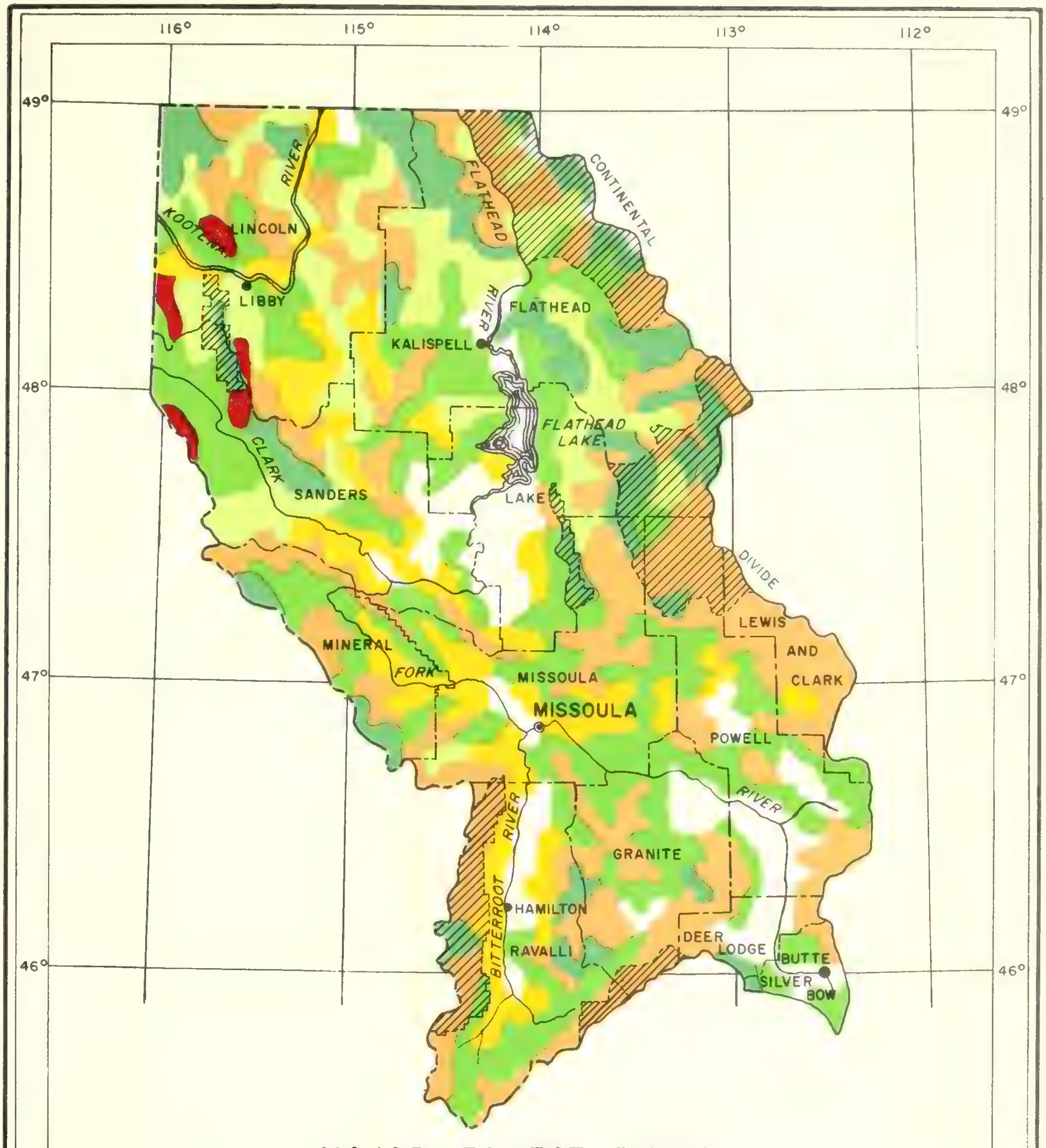
[2] Included with poles.

[3] Includes 327,000 cubic feet of miscellaneous farm timbers.

Table 26.—**Annual timber cut from live sawtimber on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Western Montana, 1956**

Products and residues	All species	Softwoods	Hardwoods
	Thousand board feet[1]		
Roundwood products:			
Saw logs	809,427	807,280	2,147
Veneer logs and bolts	(2)	(2)	(2)
Cooperage logs and bolts	0	0	0
Pulpwood	561	486	75
Piling	(3)	(3)	(3)
Poles	14,271	14,271	0
Mine timbers	29,622	29,622	0
Misc. industrial wood[4]	1,437	1,437	0
Posts	126	126	0
Fuelwood	708	654	54
All products	856,152	853,876	2,276
Logging residues	32,175	32,091	84
Timber cut	888,327	885,967	2,360

[1] International ¼-inch rule.
[2] Included in saw logs to avoid disclosing individual operations.
[3] Included with poles.
[4] Includes 126,000 board feet of miscellaneous farm timbers.



MAJOR FOREST TYPES WESTERN MONTANA

1962

FOREST SURVEY—INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE

Scale

20 10 0 20 40 Miles

LEGEND

🟩	DOUGLAS—FIR	🟧	LODGEPOLE PINE
🟨	PONDEROSA PINE	🟩	SPRUCE—FIR
🟥	WHITE PINE	☐	NONFOREST
🟩	LARCH	▨	RESERVED LAND

WOOD · WATER · FORAGE · WILDLIFE · RECREATION
FOREST SERVICE
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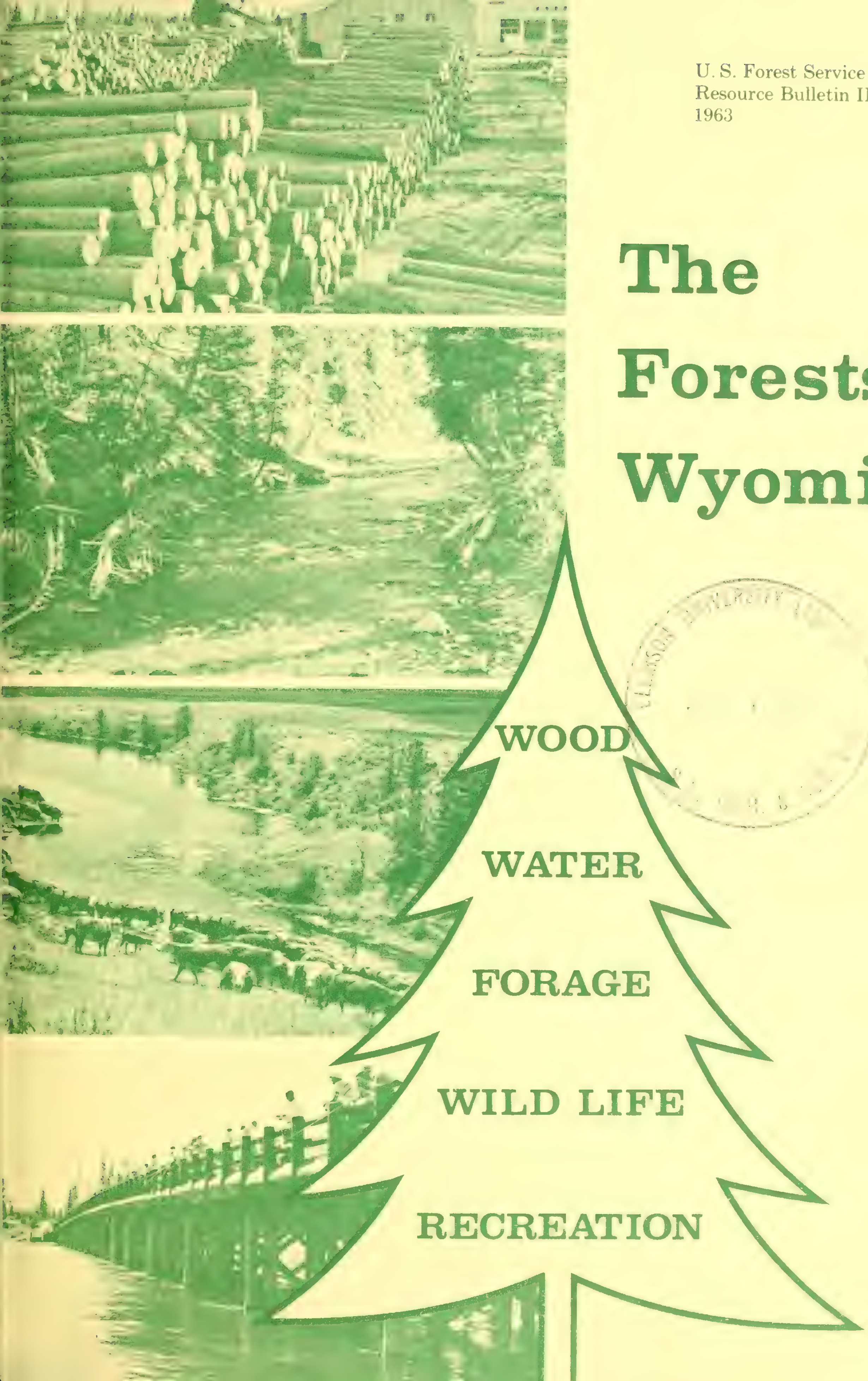
DEPARTMENT OF AGRICULTURE

U. S. Forest Service
Resource Bulletin INT-2
1963

The Forests of Wyoming



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U. S. FOREST SERVICE RESOURCE BULLETIN INT-2 1963

THE FORESTS OF WYOMING

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INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
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FOREST SERVICE — U. S. DEPARTMENT OF AGRICULTURE

FOREWORD

This report is based on the first comprehensive survey of Wyoming's forest resources. The survey was conducted as part of the continuing nationwide Forest Survey. Fieldwork started in 1957 and was completed in 1960.

Wyoming includes parts of two Regions of the U.S. Forest Service. The area to the east of the Continental Divide is in the Rocky Mountain Region with headquarters at Denver, Colorado; the area to the west is in the Intermountain Region with headquarters at Ogden, Utah. The two Regions cooperated with the Intermountain Forest and Range Experiment Station and the Rocky Mountain Forest and Range Experiment Station in field sampling, mapping, and compilation.

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SIGNIFICANT FINDINGS[1]

FOREST AREA

- The forest area is 9.8 million acres or 15.7 percent of the area of all land in the State.
- The commercial forest area is 4.9 million acres or 50 percent of the total forest land.
- Lodgepole pine is the principal type and covers 37 percent of the commercial forest.
- Sawtimber stands occupy 60 percent of the commercial forest.
- The public owns 82 percent of the commercial forest area, and the National Forests administer 69 percent.

TIMBER VOLUME

- There are 22.6 billion board feet[2] of sawtimber of which more than one-third is spruce and one-fourth is lodgepole pine.
- Eighty-four percent of the sawtimber volume is on National Forest lands.

STAND CONDITIONS

- Most sawtimber stands and many poletimber stands are overmature and are adding little net growth.
- Insects and diseases account for two-thirds of the annual mortality.

TIMBER USE

- The output of timber products in 1962 was 7 percent greater than 1957.
- Ninety-four percent of the primary timber products cut in 1962 was saw logs for lumber. Wyoming lumber output for that year was 116.5 million board feet.[3]
- About 80 percent of the 1962 saw log output was east of the Continental Divide.
- In 1962 Wyoming's timber cut amounted to only 0.29 percent of the State's inventory of sound live trees. This cutting rate is less than one-half the rate for the entire Mountain State area.

WATER, RECREATION, AND GRAZING

- Competition is increasing rapidly for Wyoming water, both inside and outside the State. Only one-sixth of the runoff is used in Wyoming.
- Outdoor recreation has increased much more than any other forest use since 1946. On Wyoming National Forests, the increase was almost tenfold or a much more rapid rate than for the Nation or for the Mountain States as a whole.
- Since World War II, cattle grazing on National Forests has remained stable, but sheep grazing has declined by almost one-third.

---

[1] *This survey indicates that Wyoming has 1.4 times more commercial forest area and 1.9 times more live sawtimber volume than was reported for 1952 by "Timber Resources for America's Future." Actual changes in forest stand conditions in that period were probably minor. The most recent figures are based on a complete survey, whereas the previous estimates were not. Also, because of changed utilization standards, a large area formerly classed as unproductive is now considered to be productive and is classified as commercial forest.*

[2] *International 1/4-inch log rule board-foot volumes are used throughout this report unless otherwise stated.*

[3] *Preliminary estimate.*

FORESTS WITH MANY VALUES

Only about 16 percent of the State of Wyoming is forest land. Nevertheless, this forest area of 9.8 million acres produces timber, water, recreation, and grazing that are very important to the State and the Nation. Some of these products or uses have been important for a long time. However, recreation is only beginning to come into its own. The grazing load is about all the forests can support at the present time, but there is a great opportunity to expand the other uses. In considering the timber resource under present and future conditions of forest management, timber use cannot be considered apart from the demands on the forest for water, recreation, and grazing. Few acres, if any, can be managed for one use alone. For this reason the demands of water, recreation, and grazing uses are discussed in addition to the timber resource — the principal topic of this report.

Timber use developed early but has been erratic

Wyoming, although not a stopping point in the original westward trek of the American lumber industry, did provide vast numbers of the railroad ties that facilitated the movement of the lumber industry from the Lake States to the Pacific Northwest. Extensive areas of lodgepole pine suitable for ties were a boon

Forested slopes of the Big Horn National Forest rising from the treeless plains west of Sheridan. Wyoming's commercial forests are largely on mountain slopes and lie between 7,000 and 10,000 feet in elevation, but in the Black Hills they come down to about 4,000 feet. Forest land below or above these elevations is of little commercial value for timber production, but most of it is very important for watershed protection, wildlife, and grazing.

to the Union Pacific Railway in its construction of the first transcontinental railroad through Wyoming in 1867-69. During the next several decades as railroads fanned out through the West, "tie hacks" hewed millions of ties from Wyoming trees. During this period timber cut in Wyoming reached a peak that was not exceeded until the late 1950's. The tie hack with his broadax finally gave way to the greater efficiency of sawmills. This did not occur rapidly. Even as late as 1927, most of the ties were hand hewed at Fox Park and other big tie operations.

Many sawmills were built in Wyoming shortly after 1900. However, lumbering has never been a stable enterprise and the number of plants has fluctuated widely over the years. For example, saws were singing in 88 Wyoming mills in 1909, but the number of active plants declined to 41 by 1920. There were 194 active sawmills in 1948, but once again difficult times for many mills whittled the total to about 74 in 1962. During this period, boards and dimension lumber gradually assumed more importance as sawmill products. In some areas, however, ties remained the principal sawmill product until the early 1950's.

Roundwood products — mine timbers, poles, and posts — have been cut in vast numbers from Wyoming's straight pole-size trees. Now, however, they make up only a little more than 5 percent of the total timber output as shown by the following estimate for 1962:

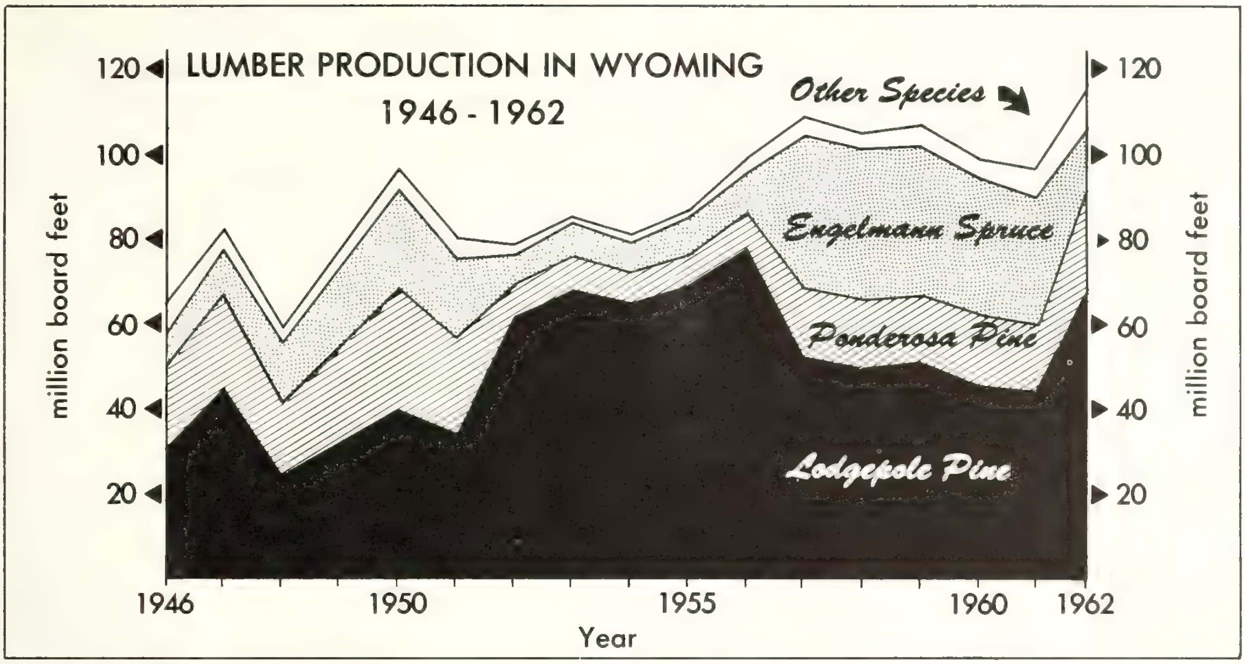
Output of Timber Products

	Thousand cubic feet
Saw logs	**19,617**
Posts and poles	**79**
Mine timbers[1]	**54**
Pulpwood (round)	**464**
Miscellaneous farm timbers	**409**
Fuelwood[1]	**109**
Miscellaneous industrial wood	**32**
Total	**20,764**

---

[1] *Mostly from dead timber.*

A "tie hack" hewing a railroad tie from lodgepole pine on the Medicine Bow National Forest, in about 1927. This was near the end of a romantic era during which millions of ties were carved from the timber by the broadaxes of husky snoose-chewing tie hacks—2.3 million were hewed in 1899 alone. In the early days great numbers of ties were floated down the Green River, North Platte River, Wind River, and other waterways. Treating plants have operated for many years at Riverton and Laramie.



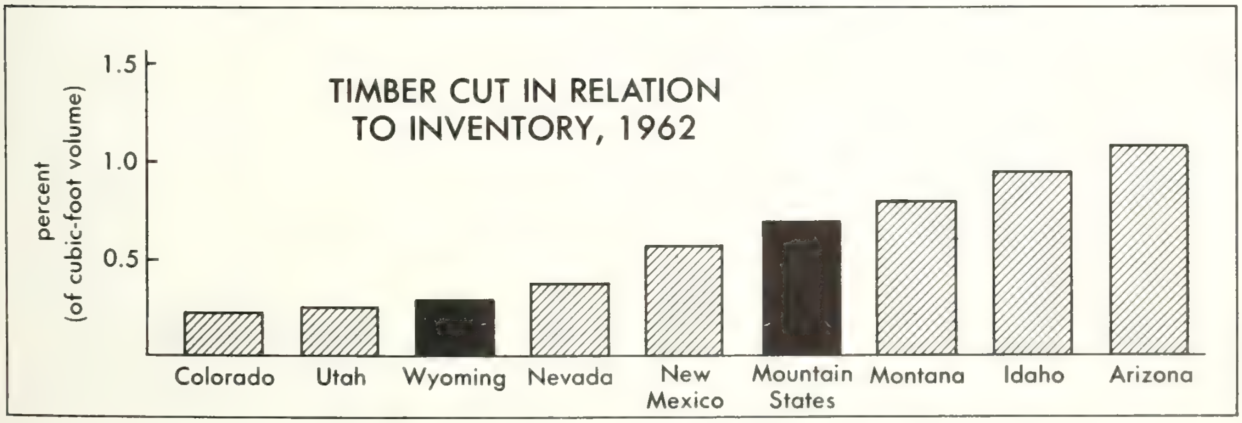
The output of timber products has been rising as is shown by data available for three postwar years:

Year	*Thousand cubic feet*
1952	**17,966**
1957	**19,388**
1962	**20,764**

Preliminary estimates for 1962 show a lumber production of 116.5 million board feet, or an increase of about 7 percent over 1957.

About one-half of the lumber that has been sawed from Wyoming's forests has come from lodgepole pine. Prior to 1912, ponderosa pine was the principal species used by sawmills. However, lodgepole pine moved into the lead about that time and has subsequently been the leading species for lumber. Trends in lumber production among species since 1946 are shown graphically above. The distribution by species in 1962 is as follows:

	Percent
Lodgepole pine	**58.4**
Ponderosa pine	**19.0**
Engelmann spruce	**15.2**
Douglas-fir	**4.7**
Other species	**2.7**

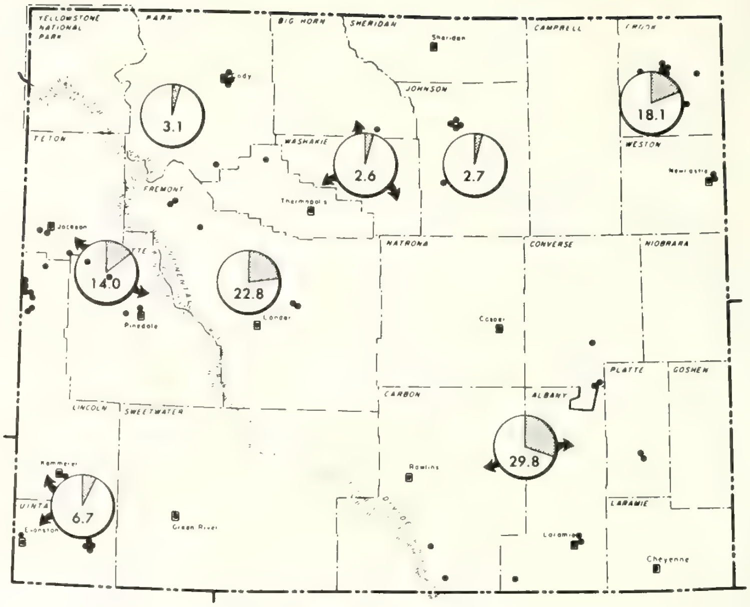


WYOMING SAWMILLS AND PERCENTAGE OF SAW LOG PRODUCTION BY COUNTY — 1962

● Sawmill reporting saw log receipts in 1962

◔ 25.0 Percent of State's saw log production (not shown in counties or groups of counties with less than 2.6 percent)

In addition to the 56 mills shown on the map, there was an estimated 20 active mills for which saw log receipts were not reported in the 1962 timber products survey.

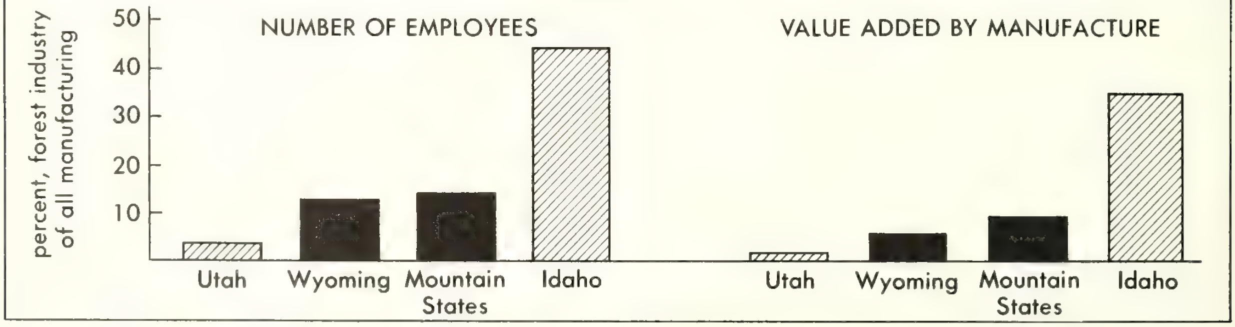


The percent of the inventory harvested annually serves as a rough measure for comparing the development of timber use in Wyoming with that in other Mountain States. Wyoming ranks among the lowest of the eight states (see the chart on page 3). In 1962 only 0.29 percent of the cubic volume of timber in Wyoming was logged. This is less than half the rate of cutting in the Mountain States as a whole. Utilization has been uneven, however. Although most of the forest is being logged at considerably below the sustained yield rate, parts of the eastern end of the State, particularly the forests of the Black Hills, are as intensively managed and utilized as any other areas of comparable size in the West. Advantages in accessibility and transportation costs to midwest markets are reflected in the fact that with only about 57 percent of the State's inventory, the area east of the Continental Divide accounts for about four-fifths of the saw log cut.

Although Wyoming's forest industry is not large, it is nevertheless very significant in the State's manufacturing economy. Data for 1958 show that about 27 percent of Wyoming's manufacturing establishments, and one out of eight manufacturing workers are engaged in harvesting timber, or processing it in primary or selected secondary industries (*12*).[4] About 7.4 percent of the value added to materials by manufacturers is attributable to forest industries.

[4] *Italicized numbers in parentheses indicate numbered references on page 24.*

FOREST INDUSTRIES IN RELATION TO ALL MANUFACTURING INDUSTRIES, 1958



Source: U. S. Bureau of the Census

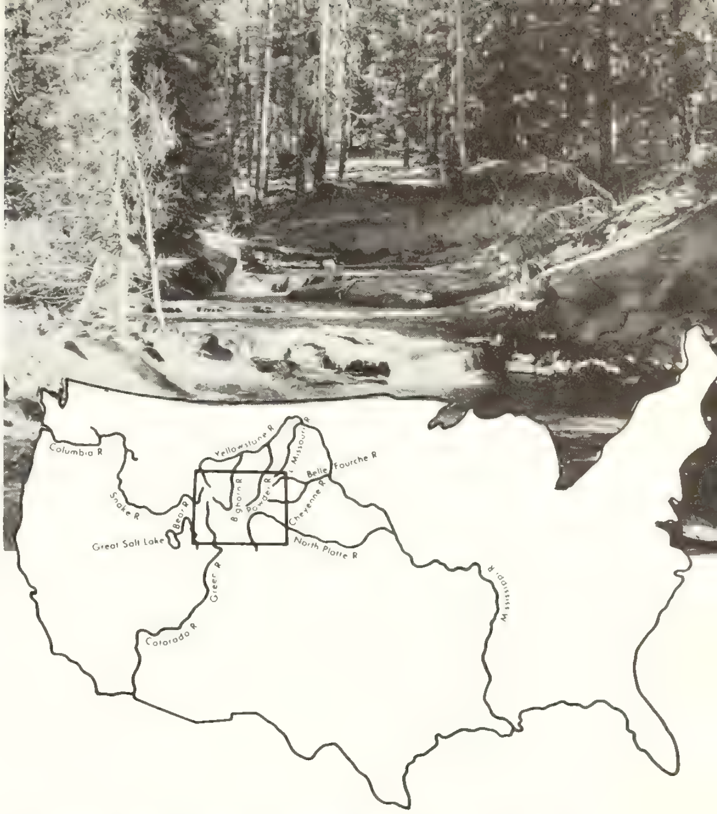
Although the present development of Wyoming's timber industry is not outstanding either in relation to that of other states or in comparison with other forest uses within Wyoming, it can be greatly enlarged. There is a potential not only for immediate expansion of the cut, but a more important potential for long-term, sustained production and consequent continuing economic benefit to the State. First, however, a number of important problems must be solved. These will be discussed later in this report.

Wyoming water is widely distributed

The statement by a member of the Wyoming Natural Resources Board (*17*), "Water is the key to the present and future development of our State," supports the opinion held by many that water is the most important product of Wyoming's forests. This follows from the fact that lands classified as predominantly forest produce substantially more than one-half the State's annual water runoff. Forests and other lands within the National Forests comprise less than 15 percent of the area of the State but produce about 54 percent of the runoff (*8*).

The importance of Wyoming's forests for water production has been recognized since early settlement. Watershed protection was a principal reason for creating the Yellowstone Park Timberland Reserve (later the Shoshone National Forest) in 1891, thus marking the start of the National Forest system. The other eight National Forests, lying wholly or partly within Wyoming, were established by 1908. For the most part, they are on the mountains and therefore in the area of greatest precipitation.

Water from Wyoming's forest land is very widely distributed within the United States — probably more widely than the water runoff from any other state. Of the annual runoff of about 15 million acre feet, only about 2.5 million is currently being consumed within the State (*16*). As shown in the map on this page, the five-sixths of the runoff that leaves Wyoming flows into four major river basins. About 75 percent of the State is in the Missouri River system, 18 percent in Colorado River drainage, 5 percent in the headwaters of the Columbia River, and about 2 percent of the area feeds the Bear River and ultimately Great Salt Lake.



Wyoming water flows to many parts of the United States. Streams, such as Brooks Lake Creek (above) on the Shoshone National Forest, supply water to rivers serving such widely separated places as Portland, Los Angeles, New Orleans, and northern Utah.

The 12.5 million acre feet of water that annually flow across Wyoming's borders are important to many downstream localities. This water will become even more valuable as the years go by as indicated by the forecast that national water use will increase about 47 percent in the 15-year period 1960-75 (*10*). The North Platte River, which drains much of southeastern Wyoming, is one of the most completely regulated streams in the United States. This river is highly important for irrigation and other uses, not only in Wyoming but in Nebraska and other downstream states. And there is already a particularly hot scramble among downstream states for water of the Colorado River.

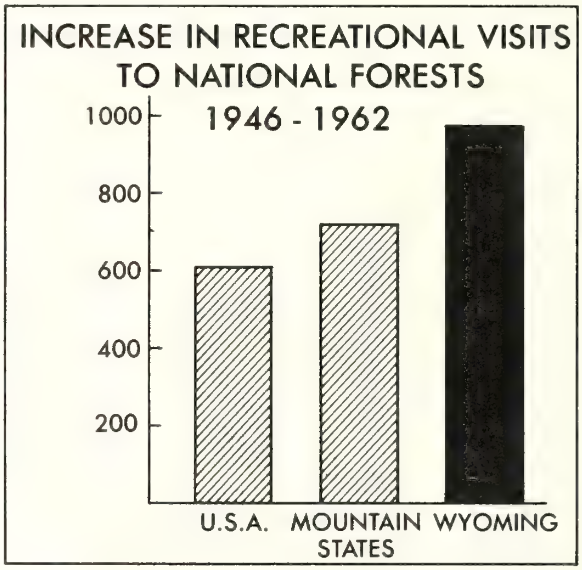
Within Wyoming, the principal consumptive use of water is for irrigation. About 1.5 million acres of farmland is irrigated, and of the cropland harvested in 1959, about two-thirds was irrigated (*11*). Within recent years demands for water have been increasing significantly for domestic, livestock, and industrial uses. Greater demands are also being made for water for outdoor recreation. These include the creation or maintenance of waterways for fish, wildlife, and boating, and the dilution of polluted streams (*7*).

To satisfy these varied and increasing demands, many water storage and distribution developments are planned or underway. It is anticipated that these developments will increase the State's consumption of water from 2.5 to about 4 million acre feet a year (*16*).

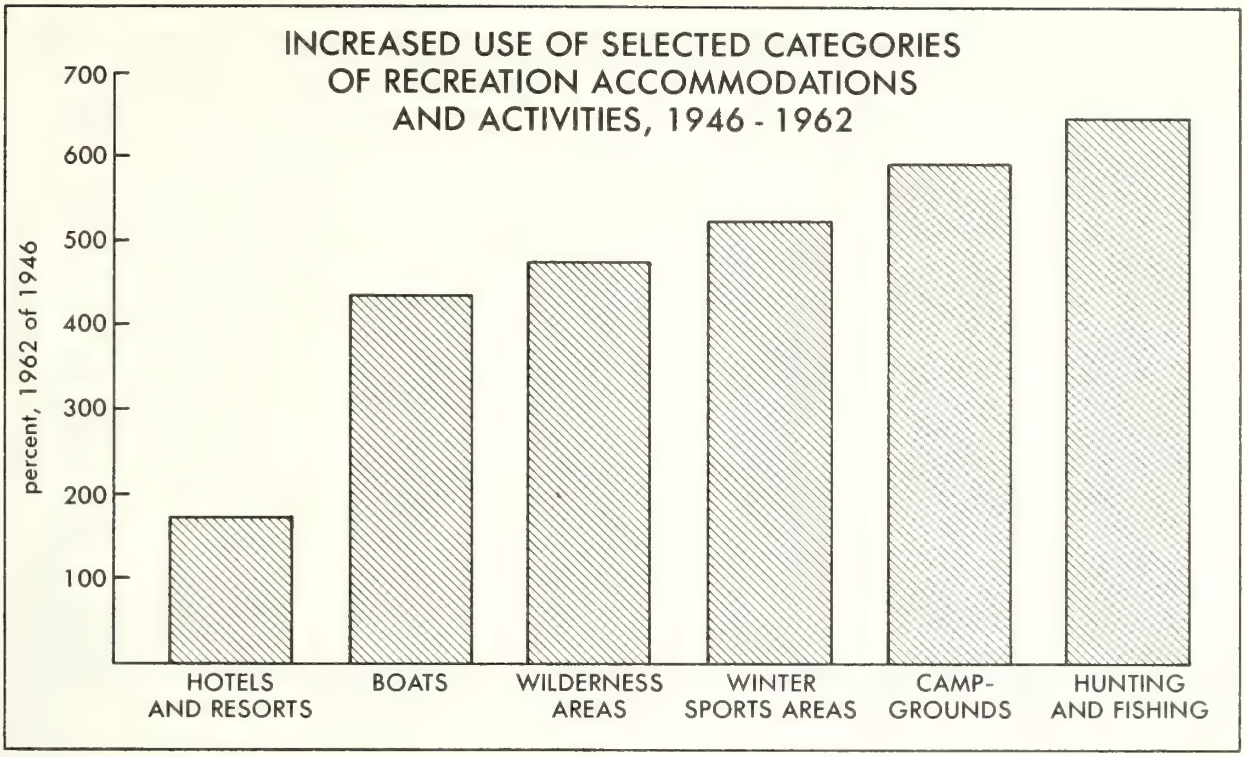
Recreation is booming

No state offers a bigger package of attractions for forest recreation than Wyoming. In addition to some of the most magnificent scenery in the country, opportunities for camping, trail riding, hiking, boating, hunting, and fishing have all contributed to recreation's surging development in recent years.

Interest in Wyoming's recreation potential, however, is by no means entirely recent. Yellowstone National Park was established in 1872 as the first major area in the country set aside for the preservation of natural resources. It is an interesting sidelight that recreation and scenery rather than more utilitarian values, inspired this first reservation. For



Dude pack train crossing the Thorofare Creek in the Thorofare country of the Teton National Forest. This is in the heart of big game hunting country. Wyoming's forests and water have long provided many opportunties for private enterprise based on recreation.



much the same reason, Devil's Tower became the country's first national monument in 1906.

Wyoming's forests are rapidly becoming more accessible for recreation. Before World War II, remoteness from the big centers of population was a major factor limiting recreational use. Now with the country's rapidly expanding population and the average citizen's greater mobility, more leisure time, and larger disposable income, Wyoming's forests have in effect become the backyard of Americans from coast to coast. In fact, there are indications of an even greater increase in recreation uses of the forests in Wyoming than in the Nation and in the Mountain States as a whole. The preceding chart shows the extent of change on National Forests between 1946 and 1962.

The postwar increase in the popularity of forest recreation has been felt by all public agencies and private enterprises concerned with furnishing facilities and services. These include various agencies of the State of Wyoming, the National Park Service, the Forest Service, the Bureau of Land Management, and private enterprises such as dude ranches, hotels, resorts, and others. The general increase in various types of use is indicated in the chart shown above, which is based largely on National Forest statistics.

Remoteness, which once delayed development, is now an important attraction in its own right. Wyoming's National Parks and wilderness areas of the National Forests provide assurance that there will be some relatively uncrowded areas in the future. Wyoming has 2.6 million acres of wilderness-type areas, or more than any other state except Idaho. In addition to this, Yellowstone and Grand Teton National Parks include 2.3 million acres that, except for a small strip along the highways, is wilderness too.

The National Parks and the National Forests are heavily used for a variety of forms of recreation. In 1962, for example, Yellowstone Park had 1.9 million visitors and Grand Teton Park 1.8 million. National Forests measure their recreation use in visits rather than visitors. The nine National Forests, wholly or partly in Wyoming, had 3.9 million recreation visits in 1962, classified as shown below:

Campgrounds	432,200
Picnic areas	406,400
Winter sports	94,200
Organization camps	19,100
Hotels or resorts	221,900
Recreation residences	40,300
Wilderness areas	45,800
Other forest areas	2,650,200
Total	3,910,100

Of the visits to "other forest areas" listed above, 715,000 were by hunters and fishermen. Between 1946 and 1962 the estimated kill of big game on the National Forests of Wyoming increased from 17,000 to 53,000.

Big game is one of the major attractions for sightseeing as well as hunting. Deer, elk, moose, black and grizzly bear, bighorn sheep, and other important game species provide annual sport for many hunters. The country's largest elk herd winters at Jackson Hole. Maintaining forage production and soil stability on the ranges used by these elk and coordinating their use with other uses of the forest lands are important problems.

Wyoming provides some of the country's most diversified and high quality inland sport fishing. The State has a number of species of trout; cutthroat is native, and eastern brook, rainbow, brown, mackinaw, and California golden have been introduced. The National Forests alone have about 4,300 miles of fishing streams and about 46,400 acres of fishing lakes. Big areas of water impoundment outside the National Forest, such as Flaming Gorge Reservoir, add substantially to the State's fishing resource.

Since World War II the expanding recreation activity has become an increasingly important competitor for public land. This competition has required development of guides covering priority of use for most of the public forest outside the National Parks. For example, on the lower slopes, grazing allotments must be coordinated with the winter forage requirements of wildlife. And on the

Bull moose in the Yellowstone River. Moose, as well as other species of big game, attract many hunters to Wyoming's forests. In 1961, hunters harvested 776 moose—a big take in comparison with other states. Hunter harvest of other big game was: elk, 11,422; black and grizzly bear, 437; deer, 84,677; antelope, 34,873; bighorn sheep, 88.

middle slopes, timber management must consider scenic values, campgrounds, and other recreation uses, particularly along roads and waterways.

Grazing reached an early peak

Wyoming's extensive areas of wild-land forage are a highly important factor in the State's big production of sheep and cattle. In 1959, about 9 percent of the cattle and 15 percent of the sheep grazed on National Forest lands. Much additional range was provided by woodland areas outside the National Forests.

Sheep and cattle have ranged Wyoming's mountain slopes for many decades. The forage on these wild lands has made a substantial contribution to the economy of the State. In fact, grass and other forage have been most heavily used of all the wild land resources. National Forest statistics, which probably reflect the trend in use of the entire range, show that a peak for cattle was reached in 1921. After a sharp drop between 1921 and 1924, the number of cattle has subsequently remained fairly stable. Sheep, on the other hand, have now dropped in number to about 44 percent of the level during World War I. Since World War II the decline has been about one-third.

Most livestock grazing is on parks and grassland and brush openings found intermingled with the commercial forests, rather than in the commercial forests themselves. However, some commercial forests are grazed. The principal grazed areas are grasslands, sagebrush, aspen, and noncommercial ponderosa pine stands found typically in valley bottoms, lower slopes, and at the forest fringes. Alpine and subalpine ranges found at or above the upper timberline are grazed in some areas by cattle but most extensively by sheep.

As demands for forage have increased in recent years, range management has intensified. Sagebrush control with herbicides has become a widespread practice and has resulted in large increases in forage production. Improved management practices, such as rotation and deferred grazing, are now being used in some sections to improve range conditions and increase forage and livestock production.

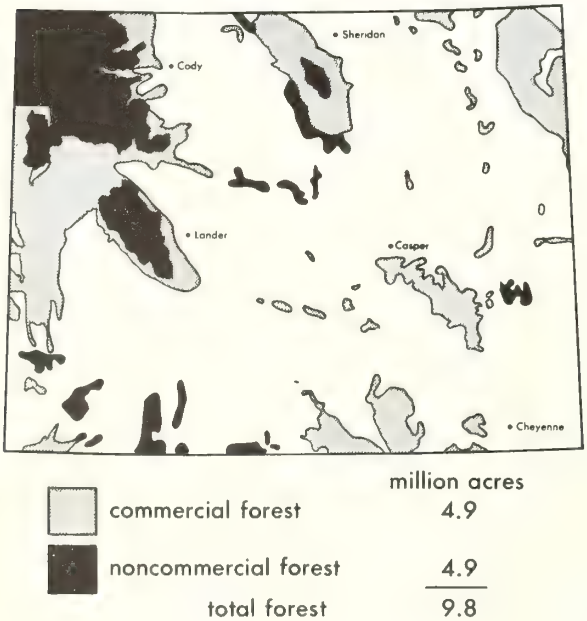
White-faced Hereford cattle on summer range at about 7,500 feet in elevation on Shoshone National Forest west of Cody. In 1961, the National Forests were grazed by about 114,000 head of cattle and horses and 334,000 sheep.

FOREST CONDITIONS

The forest area is dispersed

Wyoming has four principal timbered areas, all lying on well-defined mountain formations. The largest straddles the Continental Divide in the northwestern part of the State. The others are in the Big Horn Mountains, the Bear Lodge Mountains of the Black Hills, and the Laramie, Medicine Bow, and Park Ranges near the southeastern corner of the State. Scattered among these four blocks are a number of islands of forest on isolated ridges and peaks within the Wyoming Basin and the Great Plains.

The ponderosa pine forests of the Black Hills occur above 4,000 feet in elevation. However, the lower limit of most of the rest of Wyoming's forest is considerably higher than that. More than 90 percent of the commercial forest grows in a band between 7,000 and 10,000 feet above sea level.



	million acres
▢ commercial forest	4.9
■ noncommercial forest	4.9
total forest	9.8

About one-half of the forest area is classed as commercial. This is land capable of producing usable timber and not reserved from industrial use because it is in National Parks, National Forest wilderness areas, or other public recreation areas. There is a degree of optimism in the commercial classification as it includes many areas on steep slopes and unstable soils that cannot be logged at present without causing erosion and impairment of the productive and hydrologic functions of watersheds. National Forests are generally withholding these areas from timber harvest pending the development of suitable logging equipment and techniques.

Almost two-thirds of the noncommercial forest is so classified because it is reserved, although, as the following tabulation shows, part of the reserved area is also nonproductive:

	Million acres
Reserved-productive	**2.6**
Reserved-unproductive	**.5**
Unreserved-unproductive	**1.8**
Total	**4.9**

The productive area of about 2.6 million acres occurs mainly at midelevations and includes about 1.5 million acres of lodgepole pine stands in the National Parks.

Unproductive forest occurs at all elevations. About half the 1.8 million acres of unreserved-unproductive area is either just below timberline or in patches on steep, thin-soil slopes within the commercial forest; the other half is below the commercial forest.

The commercial forest is mostly overmature but there are few large trees

Present timber stands in Wyoming contain many old-growth trees. Three out of every five acres support a sawtimber stand and a high proportion of the timber is overmature. Of the 2.9 million acres of sawtimber, however, only 15,000 acres is classed as large saw timber — 21 inches and larger. Furthermore, a great many stands become mature before ever reaching sawtimber size.

Noncommercial forests. Stands of juniper, chaparral, and scrubby aspen occur under the dry conditions below the commercial forest. These lands comprise about 43 percent of the unproductive forest area. The photo above shows a stand of juniper south of Kemmerer. At high elevations the noncommercial forest consists mostly of poorly developed fir, spruce and limber, whitebark, and lodgepole pines. Despite adequate rainfall, growing conditions are poor because of other adverse climatic and physiographic conditions. The photo below shows this type of forest as seen from the Skyline Drive near Fremont Lake on the Bridger National Forest. In addition to the noncommercial forest at low and high elevations, such as shown here, there are many islands within the commercial forest at mid-elevations.

Lodgepole pine small sawtimber on the Medicine Bow National Forest. Lodgepole pine grows on more acres than any other species in Wyoming. As a timber type it occupies 1.8 million acres or more than one-third of the commercial forest. It is also an important component of several other timber types. Over extensive areas the species has come in following fires and as a result occupies land that could be growing other species. Many stands are far too dense and competition results in small trees throughout the life of the stand. Almost one-half the area of the type is in sawtimber stands. Most of these stands and many of the poletimber stands are overmature. Over the years, lodgepole pine has almost always provided the major portion of the timber cut for all products in the State. Since 1909 an estimated 1⅓ billion board feet of lumber products have been sawed from lodgepole pine in Wyoming.

In general, Wyoming sawtimber trees are not greatly different in present average diameter and volume from those found further north or further south. However, as shown in the tabulations below, there are differences when an individual species is compared from one area to another. These differences result from the effect of a number of factors — soil, climate, stand age, density of stocking, diseases, and so forth.

Average diameter of sawtimber trees

	Western Montana	*Wyoming*	*Colorado*
Lodgepole pine	**13.1**	**13.8**	**13.5**
Engelmann spruce	**18.1**	**16.7**	**15.7**
Douglas-fir	**16.2**	**16.7**	**15.7**
Ponderosa pine	**17.8**	**14.5**	**15.4**

Average net volume per sawtimber tree

	Western Montana	*Wyoming*	*Colorado*
		Board feet	
Lodgepole pine	**129**	**139**	**128**
Engelmann spruce	**368**	**240**	**209**
Douglas-fir	**165**	**169**	**131**
Ponderosa pine	**223**	**83**	**103**

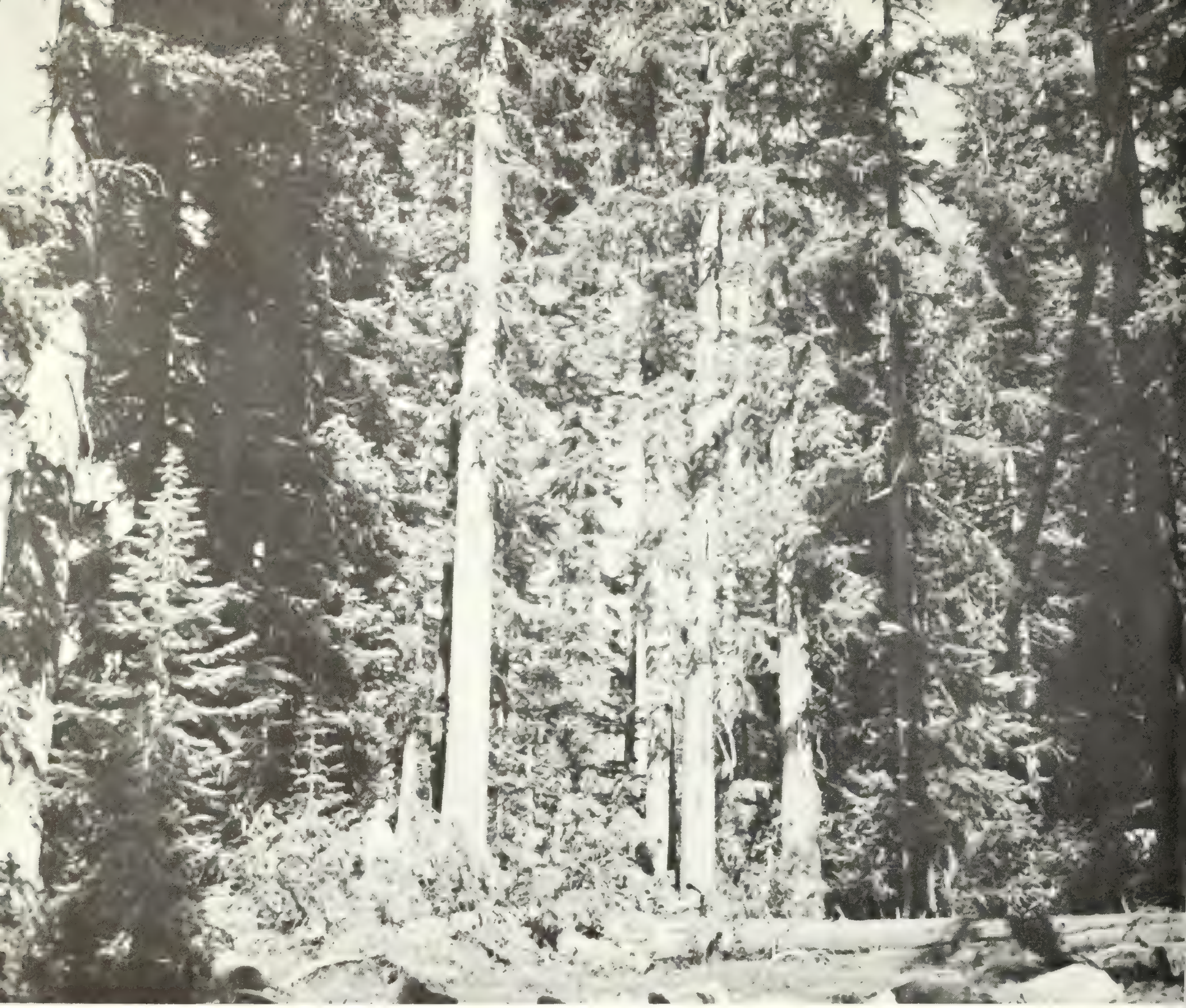
More than one-half the cubic volume in the commercial forest is in sawtimber trees. These trees have a volume of 22.6 billion board feet, three-quarters of which is in trees between 11 and 21 inches d.b.h.; the remainder is larger timber. The sawtimber volume by species is as follows:

	Billion board feet
Engelmann spruce	**8.0**
Lodgepole pine	**5.8**
Douglas-fir	**3.5**
Ponderosa pine	**2.1**
Other	**3.2**
Total	**22.6**

The average net volume in sawtimber stands is 7,258 board feet per acre. While this is low compared to many other areas, it is about average for the Mountain States.

About 82 percent of the commercial forest area and 90 percent of the sawtimber volume is in public ownership — principally in the National Forests.

Dense stand of ponderosa pine about 60 years old on a medium site. Trees are 6 to 12 inches in diameter. This is representative of stands covering much of the Black Hills area. This type of stand after thinning is illustrated on page 19. The ponderosa pine type occurs on almost 1 million acres or one-fifth of the commercial forest area. More than 70 percent of the type is classed as sawtimber but stands are largely less than 100 years old. Ponderosa pine lands are generally low in productivity compared with those occupied by other major types in the State. Furthermore, the sites in Wyoming are among the lowest for ponderosa pine in the western United States. Despite environmental handicaps this species has a long history of heavy and sustained use. Since 1869 about one-fourth of the lumber cut in the State has been ponderosa pine, and until about 1912 it was the leading lumber species. The high rate of use results from desirable qualities of the wood, accessibility for logging, and the occurrence of the type in the eastern half of the State which has good rail and road networks and is close to midwestern markets. Also, on much of the area there is no problem in obtaining natural regeneration, and therefore this is not a factor that inhibits harvesting. In the Black Hills less than 2 percent of the area of the type, and practically none of the sawtimber area, is classed by Survey as poorly stocked. This compares with statewide figures for ponderosa pine of 24 and 28 percent respectively.



Engelmann spruce sawtimber on the Medicine Bow National Forest. This stand is more than 300 years old and has many trees over 24 inches in diameter. Dominant trees are about 100 feet high. Engelmann spruce and subalpine fir are the principal species that make up the fir-spruce type, which covers about 847,000 acres . More than 80 percent of the type is classed as sawtimber, and the majority of sawtimber trees are overmature and of high risk for epidemic losses from Engelmann spruce beetle. The fir-spruce type generally occurs at higher elevations than any other type. It is the most common type immediately below timberline, but it also grows at lower elevations as stringers along stream bottoms and on moist benches. Subalpine firs are considerably more numerous than spruce but are much smaller and have a total volume of only about 1.5 billion board feet as compared with 8.0 billion of spruce. If the timber cut were accelerated to liquidate the old-growth forest at a rate more nearly comparable to the theoretically sustainable cutting rate, protection problems in the spruce forest should gradually diminish. However, difficulties in regenerating spruce following logging discourage forest managers from greatly increasing the cut.

Douglas-fir small sawtimber, Teton National Forest. From the standpoint of timber production, Douglas-fir is the most important of a number of "minor" species. Since 1900 less than 5 percent of all lumber cut in the State has been Douglas-fir and there has been no increase in the annual cut since World War II. The Douglas-fir type grows on about 701,000 acres and is largely old-growth sawtimber. About 40 percent of the 3.5 billion board feet of sawtimber is in trees 21 inches and larger. Although diameters of Douglas-fir sawtimber trees are comparable to those of Engelmann spruce, volume of Douglas-fir is considerably less because trees are shorter and more defective. They are also very limby and consequently the lumber has many knots. Still another deterrent to greater use is that Douglas-fir frequently grows on very steep slopes with unstable soils.

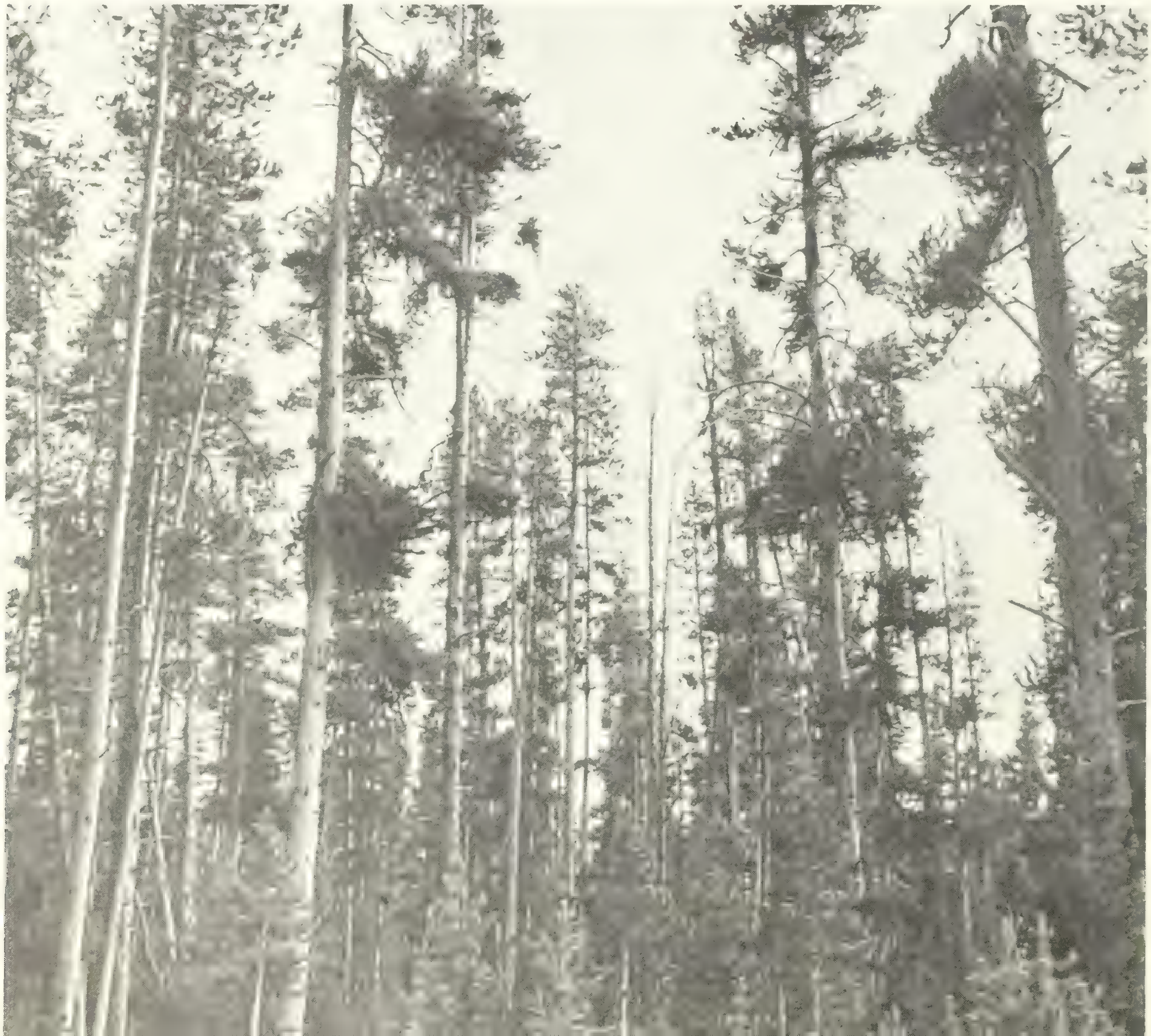
The other minor species for timber production are whitebark and limber pines, aspen, and cottonwood. The two pines occur as a type covering 166,000 acres of rocky and exposed land along the upper range of the forest. The short, limby nature of these pines results in low-grade logs which are uneconomical to harvest. The aspen type covers about 320,000 acres, of which about two-thirds is in poletimber stands. On the whole Wyoming aspen is not of good quality. Cottonwood is widely distributed but grows mainly along streams at low elevations. A small amount has been cut for lumber but the principal value of the species is for shade, scenery, and riverbank protection.

Diseases and insects greatly limit timber yields

Timber volumes would be considerably greater in Wyoming were it not for the inroads by diseases and insects. These destructive agencies limit timber productivity in two ways — through outright mortality and growth loss. Two-thirds of the annual mortality is caused by diseases and insects. The toll of 33 million cubic feet a year by these agencies is more than 50 percent greater than the harvest by wood-using industries. Data are not available on the effect of diseases and insects on tree growth, but in Wyoming's predominantly old-growth forest the loss of increment may be substantially greater than the volume lost through mortality.

Dwarfmistletoe is a heavy drag on the com-

Dwarfmistletoe is a principal cause of low productivity in many lodgepole pine stands. In the stand shown below (Yellowstone Park), the sparse overstory is decadent and heavily infested with dwarfmistletoe. Clear cutting followed by slash burning is generally the only feasible means of eliminating this parasite in heavily infested stands.



mercial forests from the standpoint of retarding growth as well as causing mortality. This was brought out by a 1953-55 survey of the Bighorn and Medicine Bow National Forests (*2*), where mistletoe problems are fairly representative of those throughout the State. The survey showed that in virgin stands, those free of mistletoe had nearly 1.5 times the per acre volume found in infested stands. Levels of infestation are much higher in cutover than in virgin stands. Other findings also support the general conclusion that this parasite is causing an enormous loss of growth.

Dwarfmistletoe is particularly damaging to lodgepole pine, and about 45 percent of the sound live trees in Wyoming's commercial forest are lodgepole pine. The survey indicated that 59 percent of the lodgepole pine area was infected in the Medicine Bow National Forest and 31 percent in the Bighorn. Mistletoe is very prevalent in areas logged for railroad ties in years past. Trees that were unsuitable for ties were not logged. Thus, the operations of the tie hacks (and later of the tie mills) more often than not left partially stocked stands in which the mistletoe already there could thrive. This condition is exemplified on considerable areas of the Wind River District on the Shoshone National Forest. The extent of the condition throughout the State is not known but undoubtedly it includes almost all of the 165,000 acres of poorly stocked lodgepole pine, poletimber and sawtimber plus much of the nearly 1 million acres classed as medium stocked. These lands will not become productive of timber unless new stands are started.

Unlike dwarfmistletoe, insects increase very rapidly and kill many trees before natural factors control them. Constant vigilance is needed and prompt action must be taken against incipient outbreaks of bark beetles, in particular, to avoid catastrophic losses. The overmature Engelmann spruce stands are highly vulnerable to outbreaks of the Engelmann spruce beetle. Control of this beetle is an especially critical problem because the infested timber is often inaccessible, and spruce is difficult to regenerate following logging. The stands of ponderosa pine 60 to 100 years old are proving to be highly susceptible to outbreaks of the Black Hills beetle, contrary to expectations that this beetle would not be a serious pest after the harvest of the overmature stands. The mountain pine beetle currently is an important threat to the immature and mature lodgepole stands in many areas. After causing widespread losses in the 1930's and 1940's, mountain pine beetle population subsided until the present outbreak. Thousands of trees have been chemically treated, cut and burned, or salvaged in the past 2 years, and more of this work is being done in 1963.

Other insects and diseases have been important factors in reducing growth and causing high mortality in the past and some may be even more serious in the future. Among these are the Douglas-fir beetle, the pandora moth, pine tip moths, the spruce budworm, lodgepole pine terminal weevil, broom rusts of fir and spruce, stem rusts of lodgepole and ponderosa pines, root rots, and stem decays.

Many acres need thinning; many others need planting

Some stands have far too many trees; others have too few. Both conditions greatly affect the amount, size, and quality of timber available to harvest now or in the future. Here again, the major problem is in the lodgepole pine type. Many of the seedling-sapling and pole stands in this type that are classified as "well-stocked" are actually overstocked. Well-stocked poletimber stands in Wyoming, for example, average more than 1,200 stems per acre; stocking of less than 500 is desirable. Some of these stands are too old to benefit from thinning. Forest Survey data do not indicate the area of overstocked stands by age classes, but probably over half of the 354,000 acres of pole-size and smaller stands of lodgepole pine that are classed as well-stocked are young enough to respond to thinning. Thinnings are also needed in some young stands of Douglas-fir, fir-spruce, and ponderosa pine.

In most areas, commercial thinnings in these types will not be possible until there is a pulpwood market. In the Black Hills and part of the Medicine Bow area, however, thinning is feasible now on a commercial basis. As a matter of fact, the Black Hills area has long been noted for its intensive forestry practices in ponderosa pine stands. Thinnings have been made here for many years. Both the Black Hills National Forest and the Homestake Mining Company, the principal large holdings in this area, have their lands under sustained-yield management.

Many acres that are either not stocked or are understocked with desirable trees pose another big job that must be tackled if Wyoming's forests are to fulfill their potential. Some of the roughly 111,000 acres of nonstocked land may restock naturally. Much of

Overstocked and stagnated stand of lodgepole pine saplings on the Shoshone National Forest. Many stands such as this never reach sawtimber size by maturity. Thinning before trees are too old to take advantage of more growing space can greatly increase sawtimber yields on better sites.

it, however, should be planted, although in some areas planting is not feasible using present methods. Many of the 55,000 acres of poorly stocked aspen could also be made more productive by planting other species. There are similar opportunities for conversion in other types. Another big job involves regeneration in poorly stocked stands of lodgepole pine. As indicated previously, there are many thousands of acres of such lands that are heavily infested with dwarfmistletoe. These stands should be clear cut and burned if they are to be brought into production. Natural regeneration of lodgepole pine following burning may be adequate on many of these areas, but in some instances it will be necessary to plant. It will also be necessary to plant if conversion to other species is desired.

Recently thinned stand of ponderosa pine on the Black Hills National Forest. Trees are all at least 10 inches in diameter and are about 70 years old. About half the basal area was removed in thinning. Thinnings of this type, yielding 5 to 12 cords per acre, are becoming increasingly important commercially. Trees removed in thinning are converted into posts, poles, and pulpwood. The unthinned stand in the background is part of the stand illustrated on page 13.

DEVELOPMENT OPPORTUNITIES AND PROBLEMS

There is a substantial opportunity to increase the timber cut

In 1962, 124 million board feet of sawtimber were cut in Wyoming. The cut could now probably be more than doubled without violating the principles of sound silvicultural and multiple use management. A useful estimate of allowable annual cut[5] for the State is not possible until more data are available on the management requirements for water production, recreation, wildlife, and grazing — all of which have an impact on timber harvesting. Even if only timber production without regard to other uses is considered, allowable cut estimates can vary by 100 percent or more. The variation will depend on assumptions that are made, especially with respect to how rapidly the large area of old growth should be cut over. While it is desirable to use this timber before its dies, a very heavy cut now could result in later reduction below sustained yield levels for a number of years.

An increase in timber cutting need not impair water, recreation, and other values; on many areas it could improve them. Opening the coniferous forest by judicious timber cutting can increase water yields (*13*). On many areas the replacement of old growth, which is subject to devastation by insects and blowdown, would provide better assurance of maintaining long-term scenic and other recreation values. On the National Forests, as well as on some other holdings, multiple use management calls for a gradual harvesting along many roads and waterways, thus minimizing adverse effects on recreation values.

The portable mill on the left produces railroad ties from the lodgepole pine on Green Mountain. The mill of the Cody Lumber Company, shown in the photo to the right (page 21) is located at the railhead in Cody. Cutting is done in mature timber on the Shoshone National Forest. Most of the lumber goes to the Twin Cities for marketing.

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[5] *Allowable annual cut is the average volume that may be harvested annually during a planned period of operation, considering the nature of the present stand, the desired degree of utilization, and the management being undertaken.*

In contrast with the present annual cut of 124 million board feet, the commercial forest of Wyoming has a theoretical capacity for ultimately producing at least 1 billion board feet a year. How close the sustained flow will approach this maximum in years ahead, will depend not only on intensity of management, the degree to which protection and regeneration problems already mentioned are solved, but on demands on the forest for uses other than timber.

A diversified industry is essential for full utilization

Almost 95 percent of the timber utilization in Wyoming is by sawmills — mostly small sawmills. These plants have not been able to make efficient use of the timber because of lack of markets for pulpwood. Without a substantial pulpwood market it is not possible to utilize that large part of the volume in mature stands that is in small trees or the big volumes of plant residues in the form of slabs, edgings, and trim. These generally have to be burned at some cost.

Fiber industry, such as pulpmills or fiberboard plants, would provide outlets for sawmill residues and perhaps much of the logging waste. Such a development would require debarking of the saw logs and chippable logging residue. In addition to providing for recovery of coarse residues, debarking benefits sawmill operations by reducing equipment maintenance and improving lumber recovery.

Timberland management would gain substantially from a market for wood fiber in addition to lumber. Clear cutting and even-aged management are desired in almost all cases. Heretofore, a market based mainly on sawtimber has left much of the cutover area in a highly unsatisfactory condition. Now, the uncut small and defective trees left in a sawtimber operation must often be felled, piled, and burned to make way for a new stand. The land manager would obviously gain if much of this material were removed as part of the logging operation. A market for small trees would be a major encouragement for thinnings.

In addition to sawtimber, Wyoming has more than 35 million cords of wood that could

be harvested for conversion to fiber products. This is a conservative estimate of the volume of all species in salvable dead trees, poletimber trees in sawtimber stands, the upper stems of sawtimber trees, and trees that are sound but of poor form. It also includes volume in mature but pole-size lodgepole pine. The distribution of wood available for conversion to fiber is shown in a general way as follows:

	Million cords
Medicine Bow National Forest	7.5
Bighorn National Forest	5.1
Black Hills National Forest	.8
Shoshone National Forest	5.9
Bridger, Teton, Targhee, Caribou, and Wasatch National Forests	10.3
Lands outside National Forests	5.5
Total	35.1

Initially a fiber industry would probably be based on a combination of sawmill residues and roundwood. It is very doubtful that the present sawmill industry, consisting of small and widely dispersed mills, could furnish enough residues within reasonable hauling distance to support a fiber plant.

An established market for fiber products would undoubtedly encourage the establishment of larger sawmills because only these larger mills can justify debarking and chipping equipment. In 1962 only seven mills in Wyoming individually produced 5 million feet or more a year. Sixty-eight percent of the active mills produced less than one-half million board feet. While small mills can continue to play an important role in some localities, they are in general less efficient and the trend in the Mountain States is now toward larger mills.

An economic study of potentials for timber utilization in western Wyoming and part of Idaho discusses possibilities for production of composition board and paper (*5*). One possibility is a pulpmill at Green River. Here, according to the findings of a Public Health Service survey in 1957 (*15*), streamflow was adequate at that time for a 150- to 200-ton-per-day sulphate mill assuming adequate provision for waste recovery. Subsequent to this survey, the Seedskadee Project was undertaken on the Green River. On completion of this project stream conditions may be favorable for a larger mill.

From the standpoint of wood supply, there is enough material in a number of areas to support small groundwood mills.

Another possibility lies in further shipment of pulpwood to out-of-state mills. In 1962 about 17,000 cords were shipped to the Lake States. This outlet, while desirable, can never offer the advantages of a pulp and paper development within the State, or at least much closer to it. The Medicine Bow National Forest has been considered as one source of supply for possible pulpmills in Colorado (*3*).

Road development should be geared to management

Forest management has been largely limited by and geared to the extent and pattern of road development. Accessible areas have been heavily exploited and some have been under intensive management for a long time. On the other hand, there are many stands of old growth which should have priority for cutting but cannot be reached.

In the past, a lack of markets for the kind and size of timber available has probably been the most important factor limiting the total cut. As markets improve there will be an increasing need for better access to timberlands. More and better roads are needed now, not only to reach utilizable timber, but also to permit cultural work in young or depleted stands.

The biggest problem of access is on the National Forests which have about 70 percent of the commercial forest area. And this area is largely on the most difficult terrain in the State. All the National Forests need more roads — some much more than others. The Bighorn National Forest, for example, estimates that 2,080 miles of road must be built if the allowable cut is to be harvested.

Much of the roadbuilding in the National Forests has been financed by timber sales, an approach which has not led to an adequate road network. In the first place, utilization and development have tended to be concentrated on the more accessible areas first; the roads have crept into the forest in steps and have not reached many remote stands most in need of cutting. On the other hand, many stands already tapped by roads tend to be overcut in relation to the property as a whole. Moreover, with an inadequate road network, National Forest Administrators are handicapped in achieving allowable cut objectives, in dealing with insect, disease, and fire control problems, and in applying cultural work where it is needed.

In addition to access roads into the timber, more and better truck routes are needed for hauling. In many areas of the State not served by railroads, trucks must do the job, but frequently on roads which are entirely inadequate for the heavy loads and long-distance hauls.

A much bigger effort is necessary if anticipated demands are to be met

The forests no less than other resources will feel the eruptive demands of a population that is expected to increase from the present 188 million to 230 million by 1976 and 350 million by 2000 (*9*). The levels of use already reached by water, recreation, and grazing leave no doubt that they will tax the capacity of Wyoming's forests in the future. Timber use will also increase though probably not so rapidly in relation to potential.

Future demands that will be made on the forests for water, timber, and recreation are indicated by a number of trends and forecasts. Water use in the United States increased from 8 percent of the supply in 1900 to 60 percent in 1960. It has been estimated that 88 percent of the total supply will be used by 1975 (*10*). By the year 2000, a threefold increase over the 1960 level is anticipated in outdoor recreation (*9*).

Two nationwide studies indicate a substantial long-range rise in wood needs. The Timber Resources Review (*14*) states that "prompt and very substantial expansion and intensification of forestry in the United States is necessary if timber shortages are to be avoided by 2000." A more recent report forecasts that the demand for forest products will probably increase by two-thirds between now and 1980 and triple by 2000 (*6*).

If these wood needs develop, Wyoming has the timber-growing potential to supply a larger portion of the cut than in the past. Pulpwood is one of the leading wood products in terms of rate of increase in national consumption[6] — and Wyoming has a lot of pulpwood. Wyoming is favored with a preponderance of soft-textured woods that are suitable for pulp. The probable effects of these factors of supply and demand are discussed more thoroughly in recent studies (*1*, *4*).

If predicted demands are to be met, the most expensive and difficult job facing timber managers is stand improvement. So far very little work has been done on the more than three-fourths of the State's commercial forest that lies outside the Black Hills and Medicine Bow areas. On the National Forests outside these areas, less than 9,000 acres has been given any cultural treatment. This includes 633 acres of successful seeding and planting, almost 3,600 acres of site preparation, and about 4,600 acres of timber stand improvement work. Unless the program is greatly stepped up, a big area of potentially productive timberland will continue indefinitely in an unproductive condition.

There will be many difficult decisions in setting development priorities for Wyoming's forest lands. These decisions become especially difficult in view of the complexities of multiple use management. And, because in the future, very few lands can be managed for timber alone, consideration must generally be given to other uses — water, recreation, grazing, and wildlife.

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[6] *Between 1950 and 1960 the per capita consumption of wood declined about 17 percent, but the per capita use of pulpwood increased 12 percent.*

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APPENDIX

TERMINOLOGY

Forest Land

The term *forest land* includes (a) land which is at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking, and which has not been developed for other use; (c) afforested areas.

At the time the fieldwork for this report was performed, the minimum unit of area for forest land classification was 10 acres with a minimum width of stringer strips of 120 feet.

The principal classes of forest land are:

Commercial forest land. — Forest land which is (a) producing, or is physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; (c) not withdrawn from timber utilization.

Noncommercial forest land. — Three classes of noncommercial forest land are recognized: *Productive-reserved, Unproductive-nonreserved, and Unproductive-reserved.*

Productive-reserved is public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

Unproductive indicates forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions or forest land so physically inaccessible as to be unavailable economically in the foreseeable future.

Forest Types

Forest land is classified into types on the basis of tree species; the type name is that of the predominant species. The predominant species is the one which has a plurality of (a) gross cubic volume in sawtimber and poletimber stands, or (b) the number of stems in seedling and sapling stands. Both growing stock and cull trees are considered in the classification. Forest types which occur on both commercial and noncommercial forest land are:

Douglas-fir
Ponderosa pine
Lodgepole pine
White bark and limber pine
Fir-spruce
Aspen
Cottonwood
Other western hardwoods

Two additional forest types which occur only on noncommercial forest land are:
Pinyon-juniper
Chaparral

Tree Size Classes

Sawtimber-size tree
A tree 11.0 inches d.b.h. or larger

Pole-size tree
A tree 5.0 to 10.9 inches d.b.h.

Seedling-sapling trees
Trees at least 1 foot high and less than 5.0 inches d.b.h.

Tree-Merchantability Classes

Sawtimber tree
Live tree of commercial species, 11.0 inches d.b.h. or larger, that contains at least one 10-foot log to a merchantable top diameter and having the likelihood of eventually containing at least a 16-foot minimum saw log. Also, at least one-third of the board-foot volume must be free from rot or other defect.

Poletimber tree

Live tree of commercial species, 5.0 to 10.9 inches d.b.h., free of rot and having the likelihood of growing into a sawtimber tree.

Sapling and seedling trees

Live trees of commercial species, less than 5.0 inches d.b.h., with form and quality to qualify as potential poletimber trees.

Growing stock trees

Sawtimber trees, poletimber trees, saplings and seedlings; i.e., all live trees except cull trees.

In discussion and tables on volumes, growth, and mortality, the term *growing stock* refers only to sawtimber trees and poletimber trees; i.e., all live trees 5 inches d.b.h. and larger (except cull trees). Saplings and seedlings are not part of growing stock in this usage of the term.

Cull tree

Live tree of sawtimber or poletimber size that is unmerchantable for saw logs, now or prospectively, because of rot or other defect, or species.

Sound cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull with at least one-half of this cull the result of sweep, crook, or other sound defect. Also included are sound trees which do not contain at least one 10-foot saw log.

b. Poletimber-size trees that are unlikely to grow into sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, crooks, or girdling by porcupine. No rot may be present.

Rotten cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull, with more than half of the cull due to rot.

b. Poletimber-size trees showing any evidence of rot in the main stem.

Mortality tree

A tree 5.0 inches d.b.h. or larger, standing or down, which has died within the past 5 years and was not a cull tree at time of death.

Salvable dead tree

Dead tree 5.0 inches d.b.h. or larger, standing or down (but not lying on the ground) which has 50 percent of more of its cubic-foot volume in sound wood.

Stand-Size Classes

Sawtimber stands

A stand with a minimum net volume per acre of 1,500 board feet (International ¼-inch rule) in sawtimber trees. Two classes of sawtimber stands are recognized:

Large sawtimber.—A stand in which the majority of the net board-foot volume is in sawtimber trees 21.0 inches d.b.h. and larger.

Small sawtimber.—A stand in which the majority of the net board-foot volume is in sawtimber trees from 11.0 to 20.9 inches d.b.h.

Poletimber stand

Stand failing to meet the sawtimber stand specifications, but at least 10 percent stocked with poletimber and larger (5.0 inches d.b.h. and larger) trees and with at least half the stocking in poletimber trees.

Seedling and sapling stand

A stand not qualifying as either a sawtimber or poletimber stand, but having at least 10 percent stocking of trees of commercial species and with at least half the stocking in seedling and sapling trees.

Nonstocked area

An area not qualifying as a sawtimber, poletimber, or a seedling-sapling stand; i.e., normally an area less than 10 percent stocked.

Stocking

Stocking is a measure of the degree to which growing space is utilized by trees. In this report it is expressed as the percentage of the available space that is occupied by tree crowns as viewed on aerial photographs.

Well-stocked stand

A stand that is 70 percent or more covered by tree crowns.

Medium-stocked stand

A stand with 40 to 70 percent coverage by tree crowns.

Poorly stocked stand

A stand with 10 to 40 percent coverage by tree crowns.

Nonstocked area

An area with less than 10 percent coverage by tree crowns.

Timber Volume

All-timber volume

Volume in cubic feet of sound wood in the bole of growing stock, cull, and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top inside bark.

Growing stock volume

Net volume in cubic feet of sawtimber trees and poletimber trees from stump to a minimum 4.0-inch top inside bark.

Live sawtimber volume

Net volume in board feet of the saw log portion of sawtimber trees.

Saw log portion

That portion of the bole of sawtimber trees between the stump and the merchantable top.

Merchantable top

The point at which the upper limit of saw log merchantability is limited either by limbs or by a minimum diameter. The latter varies with diameter class, ranging from 5 inches inside bark for trees 11 inches at breast height to 10 inches for trees 26 inches or larger.

Upper-stem portion

That part of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches inside bark.

Quality class

A classification of sawtimber volume in terms of log grades. Four grades are recognized and distinguished by the occurrence and characteristics of knots. The log grades corresponding to the quality classes are:

Grade 1 (select logs) are essentially smooth and surface clear, except that in logs 16 inches and larger in diameter a few visible knots are permitted, providing there are no more than 1 large knot, or 2 medium or small knots, or 4 pin knots. Knot sizes for all grades are:

Pin knots—0.5 inch or less
Small knots—0.5 to 0.75 inch
Medium knots—0.75 to 1.5 inches
Large knots—over 1.5 inches

Occasional logs having a greater number of knots are admitted provided these knots may be boxed in an area not exceeding one-third the area of one face or an equivalent area of two faces.

Grade 2 (shop logs) display relatively few knots of any size, so spaced that at least 50 percent of the surface of the log is in smooth, clear areas, the size of which must be at least one-fourth the girth of the log in width, by 4 feet or more in length.

A log with no more than 12 medium or smaller knots, or more than 8 large ones, may be immediately classed as grade 2. If this number of knots is exceeded, the clear area basis governs.

Grade 3 (common logs) display either (a) pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab, or (b) 16 dead knots (an average of 4 per face) averaging medium in size.

Grade 4 (low common logs) display medium, large, and very large live and/or dead knots in excess of the numbers permitted in grades 2 and 3.

Growth

Net annual growth of sawtimber or growing stock
The average annual change, calculated from the total change over a 10-year period, in net board-foot or cubic-foot volume of live sawtimber or growing stock on commercial forest land.

Mortality

Net annual mortality of sawtimber or growing stock
The average annual net board-foot or cubic-foot volume removed from live sawtimber or growing stock through death, calculated from the total net volume removed by such causes over a 10-year period.

Timber Cut

Timber cut from growing stock
The volume of sound wood in live sawtimber and poletimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Timber cut from sawtimber
The net board-foot volume of live sawtimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Logging residues from growing stock
The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging on commercial forest land and not converted to timber products.

Ownership Classes

National Forest lands
Federal lands which have been designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Other Federal lands
Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies.

State lands
Lands owned by the State.

Forest industry lands
Lands owned by companies or individuals operating wood-using plants.

Farmer-owned lands
Lands owned by operators of farms.

Miscellaneous private lands
Privately owned lands other than forest-industry or farmer-owned lands.

Principal Tree Species

	Softwoods
Douglas-fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Fir, white	*A. concolor*
Juniper	*Juniperus* spp.
Pine, limber	*Pinus flexilis*
Pine, lodgepole	*P. contorta*
Pine, ponderosa	*P. ponderosa*
Pine, whitebark	*P. albicaulis*
Spruce, Engelmann	*Picea engelmannii*
Spruce, white	*P. glauca*
	Hardwoods
Aspen, quaking	*Populus tremuloides*
Cottonwood, black	*Populus trichocarpa*

SURVEY METHODS

Area statistics were determined by two methods: (1) On National Forests, forest lands were mapped on aerial photographs according to forest type, stand size, and crown density. Photo delineations were then transferred to base maps. Non-National Forest lands within National Forests were delineated on the maps according to the ownership class. Maps were then dot counted to obtain the estimates of area by the various land and forest classes, and by ownership. (2) For lands outside National Forests a sampling procedure was used. Points were classified on Army Map Service maps and on aerial photos to determine the proportion of area by forest versus nonforest, class of forest, and ownership. A percentage of the points was checked on the ground for correctness of classification. Results of the field check were then used to adjust the map and photo estimates of proportions. Acreages were determined by applying the adjusted proportions to the area outside National Forests.

Volume estimates are based on tree measurements taken on 1,159 sample areas located at random on commercial forest lands. Sample locations were pricked on aerial photos then located on the ground and established on a permanent basis to permit remeasurement on future surveys. Each location consisted of a pair of circular plots, 5 chains apart. Each plot consisted of four circular subplots with a common center. The area of subplots and kind of trees tallied on them are as follows:

1/500 acre—live seedling-sapling-size trees.

1/50 acre—live pole-size trees.

1/5 acre—live sawtimber-size trees, and all salvable dead trees (pole-size and sawtimber-size).

1/3 acre—mortality trees of pole-size and larger.

In addition to making the customary measurements and classifications of trees for volume and quality, increment borings were taken for growth estimates.

Formulas equating field measurements to volume, growth, and mortality were applied as part of the machine data processing to provide average volumes per acre for the various classifications based on type, size, stocking, etc. These averages, applied to area estimates, provided volumes shown in statistical tables.

Estimates of timber cut are based on periodic surveys of forest industries. The latest surveys are for 1962 and are the basis for data shown in the appendix tables. Utilization trends discussed in the text are based mainly on lumber production data, since complete information on output of all products for years prior to 1957 is not available. Data for estimating the volume of logging residues are obtained by special studies on active woods operations.

RELIABILITY OF ESTIMATES

Data collected by sampling are not entirely reliable; i.e., there is a sampling error. Sufficient samples are taken to insure that the error is not above a specified maximum. Magnitude of the errors associated with area and volume estimates for Wyoming have been determined by statistical analysis of the data.

Estimates of the acreage of the various classes of forest land were determined by two procedures—mapping (5.7 million acres) and sampling (4.1 million acres). There are no sampling errors for the mapped area. Sampling errors for the sampled portion and for the total estimates of commercial and noncommercial breakdowns are shown in the following tabulation:

	Mapped area		**Sampled area**			**Total forest area**		
	Area	*SE*	*Area*	*SE*		*Area*	*SE*	
	M acres		*M acres*	*Acres*	*Percent*	*M acres*	*Acres*	*Percent*
Commercial	**3,580**	**0**	**1,273**	**33,265**	**2.61**	**4,853**	**33,265**	**0.69**
Noncommercial	**2,127**	**0**	**2,797**	**33,284**	**1.19**	**4,924**	**33,284**	**.68**
Total	**5,707**		**4,070**			**9,777**		

The sampling error for the estimated 7,458 million cubic feet of growing stock in Wyoming is ±2.7 percent.

The sampling error for the total timber cut from growing stock (21,756,000 cubic feet) is estimated at ±3.5 percent.

All errors are computed on the basis of odds of two out of three that values which would result from a 100-percent survey would lie within the range indicated by the error.

APPENDIX TABLES

Table 1.—Area by land classes, Wyoming, 1960

Land class	Thousand acres
Commercial forest land	4,853
Unproductive forest land	2,344
Productive-reserved forest land	2,580
Total forest land	9,777
Nonforest land	52,566
All land	[1]62,343

[1] *From U.S. Bureau of the Census, Land and Water Areas of the United States, 1960.*

Table 2.—Area of commercial forest land by ownership classes, Wyoming, 1960

Ownership class	Thousand acres
National Forest	3,364
Other Federal:	
Bureau of Land Management	395
Indian	124
Miscellaneous Federal	—
Total other Federal	519
State	111
County and municipal	—
Farmer-owned	622
Miscellaneous private[1]	237
All ownerships	4,853

[1] *Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 3.—Area of commercial forest land by stand-size and ownership classes, Wyoming, 1960

Stand-size class	All ownerships	National Forest	Other public	Farmer[1] and misc. private
	Thousand acres			
Sawtimber stands:				
Large sawtimber	15	15	—	(2)
Small sawtimber	2,904	1,915	411	578
Total	2,919	1,930	411	578
Poletimber stands	1,588	1,206	143	239
Sapling and seedling stands	235	176	31	28
Nonstocked areas	111	52	45	14
All classes	4,853	3,364	630	859

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *Less than 0.5 thousand acres.*

Table 4.—**Area of commercial forest land, by stand-volume classes for sawtimber and other stand-size classes, Wyoming, 1960**

Stand volumes per acre[1]	Area by stand-size classes		
	All stands	Sawtimber stands	Other stands
	Thousand acres		
Less than 1,500 board feet	1,881	11	1,870
1,500 to 5,000 board feet	1,502	1,438	64
5,000 to 10,000 board feet	843	843	—
10,000 to 20,000 board feet	507	507	—
More than 20,000 board feet	120	120	—
All classes	4,853	2,919	1,934

[1] *Net volume, International ¼-inch rule.*

Table 5.—**Area of commercial forest land, by stocking classes of all live trees and by stand-size classes, Wyoming, 1960**

Stocking class	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
70 percent or more	1,184	565	488	131	—
40 to 70 percent	2,730	1,805	851	74	—
10 to 40 percent	828	549	249	30	—
Less than 10 percent	111	—	—	—	111
All classes	4,853	2,919	1,588	235	111

Table 6.—**Area of commercial forest land, by forest types and ownership classes, Wyoming, 1960**

Forest type	All ownerships	Public ownerships	Private ownerships
	Thousand acres		
Douglas-fir	701	635	66
Ponderosa pine	992	449	543
Lodgepole pine	1,802	1,700	102
Whitebark and limber pine	166	148	18
Fir-spruce	847	816	31
Other hardwoods	20	8	12
Aspen	320	236	84
Cottonwood	5	2	3
All types	4,853	3,994	859

Table 7.—Area of commercial forest land by forest types and by stand-size classes, Wyoming, 1960

Forest type	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
Douglas-fir	701	505	155	18	23
Ponderosa pine	992	727	203	27	35
Lodgepole pine	1,802	855	805	117	25
Whitebark and limber pine	166	76	73	10	7
Fir-spruce	847	696	117	13	21
Other hardwoods	20	—	17	3	—
Aspen	320	57	216	47	—
Cottonwood	5	3	2	(1)	—
All types	4,853	2,919	1,588	235	111

[1] *Less than 0.5 thousand acres.*

Table 8.—Area of noncommercial forest land, by forest types, Wyoming, 1960

Forest type	All areas	Productive reserved areas	Unproductive areas
	Thousand acres		
Douglas-fir	318	191	127
Ponderosa pine	(1)	(1)	—
Lodgepole pine	1,951	1,756	195
Whitebark and limber pine	405	104	301
Fir-spruce	1,216	513	703
Aspen	239	16	223
Cottonwood	(1)	(1)	—
Chaparral	214	—	214
Pinyon-juniper	581	—	581
Other	—	—	—
All types	4,924	2,580	2,344

[1] *Less than 0.5 thousand acres.*

Table 9.—Number of growing-stock trees on commercial forest land, by diameter classes and by softwoods, and hardwoods, Wyoming, 1960

D.B.H. class (inches)	All species	Softwood	Hardwood
	Thousand trees		
1.0- 2.9	1,018,579	883,553	135,026
3.0- 4.9	619,657	552,226	67,431
5.0- 6.9	371,864	335,243	36,621
7.0- 8.9	220,652	202,676	17,976
9.0-10.9	111,856	107,838	4,018
11.0-12.9	62,548	59,391	3,157
13.0-14.9	36,389	35,831	558
15.0-16.9	21,137	21,006	131
17.0-18.9	12,381	12,351	30
19.0-28.9	14,312	14,312	—
29.0-38.9	1,015	1,006	9
39.0 and larger	41	41	—
All classes	2,490,431	2,225,474	264,957

Table 10.—Number of cull and salvable dead trees on commercial forest land, by diameter groups and by softwoods and hardwoods, Wyoming, 1960

D.B.H. class (inches)	Cull trees	Salvable dead trees
	Thousand trees	
Softwoods:		
5.0- 8.9	22,967	97,421
9.0-18.9	9,043	50,792
19.0 and larger	1,303	2.095
Total	33,313	150,308
Hardwoods:		
5.0-10.9	14,720	18,631
11.0-18.9	966	870
19.0 and larger	5	—
Total	15,691	19,501
All species	49,004	169,809

Table 11.—**Volume of timber on commercial forest land, by class of timber and by softwoods and hardwoods, Wyoming, 1960**

Class of timber	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Sawtimber trees:			
Saw-log portion	3,833,163	3,761,441	71,722
Upper-stem portion	322,906	300,511	22,395
Total	4,156,069	4,061,952	94,117
Poletimber trees	3,301,557	3,071,536	230,021
All growing-stock trees	7,457,626	7,133,488	324,138
Sound cull trees:			
Sawtimber-size trees	41,269	40,358	911
Poletimber-size trees	61,831	59,040	2,791
Total	103,100	99,398	3,702
Rotten cull trees:			
Sawtimber-size trees	49,655	44,237	5,418
Poletimber-size trees	35,492	15,627	19,865
Total	85,147	59,864	25,283
Salvable dead trees:			
Sawtimber-size trees	658,968	650,387	8,581
Poletimber-size trees	471,961	439,048	32,913
Total	1,130,929	1,089,435	41,494
All timber	8,776,802	8,382,185	394,617

Table 12.—**Volume of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Wyoming, 1960**

Ownership class	All species	Softwoods	Hardwoods
	GROWING STOCK *(Million cubic feet)*		
National Forest	6,046	5,870	176
Other public	579	525	54
Farmer and misc. private[1]	833	739	94
All ownerships	7,458	7,134	324
	SAWTIMBER *(Million board feet)*[2]		
National Forest	18,939	18,829	110
Other public	1,532	1,429	103
Farmer and misc. private[1]	2,161	1,988	173
All ownerships	22,632	22,246	386

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *International ¼-inch rule.*

Table 13.—Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, Wyoming, 1960

Stand-size class	All species	Softwoods	Hardwoods
	GROWING STOCK *(Million cubic feet)*		
Sawtimber stands	5,675	5,567	108
Poletimber stands	1,714	1,510	204
Sapling and seedling stands	64	52	12
Nonstocked areas	5	5	—
All classes	7,458	7,134	324
	SAWTIMBER *(Million board feet)*[1]		
Sawtimber stands	21,186	20,894	292
Poletimber stands	1,426	1,333	93
Sapling and seedling stands	10	9	1
Nonstocked areas	10	10	—
All classes	22,632	22,246	386

[1] *International ¼-inch rule.*

Table 13a.—Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by species, Wyoming, 1960

Stand-size class	All species	Douglas-fir	Ponderosa pine	Lodgepole pine	Whitebark and limber	True[1] firs	Spruce[2]	Other[3] softwoods	Hardwoods
	GROWING STOCK *(Million cubic feet)*								
Sawtimber stands	5,675	751	600	1,642	360	586	1,627	1	108
Poletimber stands	1,714	148	93	1,080	68	55	66	(4)	204
Sapling and seedling stands	64	2	(4)	44	2	3	1	—	12
Nonstocked areas	5	(4)	3	2	—	—	—	—	—
All classes	7,458	901	696	2,768	430	644	1,694	1	324
	SAWTIMBER *(Million board feet)*[5]								
Sawtimber stands	21,186	3,386	1,876	5,066	1,200	1,480	7,886	—	292
Poletimber stands	1,426	177	187	731	55	54	129	—	93
Sapling and seedling stands	10	2	(4)	1	1	3	2	—	1
Nonstocked areas	10	1	9	—	—	—	—	—	—
All classes	22,632	3,566	2,072	5,798	1,256	1,537	8,017	—	386

[1] *Subalpine and white firs.*

[2] *Engelmann and white spruces.*

[3] *Pinyon and juniper.*

[4] *Less than 0.5 million feet.*

[5] *International ¼-inch rule.*

Table 14.—Volume of growing stock on commercial forest land, by species and diameter groups, Wyoming, 1960

Species	Diameter group (inches at breast height)					
	All classes	5.0 to 10.9	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million cubic feet					
Softwoods:						
Douglas-fir	901	251	416	191	40	3
Ponderosa pine	696	248	409	38	1	—
Lodgepole pine	2,768	1,720	1,004	41	3	—
Whitebark and limber pine	430	190	208	29	2	1
White fir	1	1	(1)	(1)	—	—
Subalpine fir	643	352	267	23	1	—
Engelmann spruce	1,687	306	906	411	60	4
White spruce	7	4	3	—	—	—
Other softwoods	1	—	1	—	—	—
Total	7,134	3,072	3,214	733	107	8
Hardwoods:						
Aspen	252	221	31	(1)	—	—
Cottonwood	72	9	62	—	1	—
Total	324	230	93	(1)	1	—
All species	7,458	3,302	3,307	733	108	8

[1] *Less than 0.5 million cubic feet.*

Table 14a.—**Volume of sawtimber on commercial forest land, by International ¼-inch log rule, species, and diameter groups, Wyoming, 1960**

Species	Diameter group (inches at breast height)				
	All classes	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million board feet				
Softwoods:					
Douglas-fir	3,566	2,150	1,152	249	15
Ponderosa pine	2,072	1,894	175	3	—
Lodgepole pine	5,798	5,551	231	16	—
Whitebark and limber pine	1,256	1,095	146	10	5
White fir	1	1	(1)	—	—
Subalpine fir	1,536	1,398	136	2	—
Engelmann spruce	8,004	5,071	2,517	386	30
White spruce	13	13	—	—	—
Other softwoods	—	—	—	—	—
Total	22,246	17,173	4,357	666	50
Hardwoods:					
Aspen	159	159	(1)	—	—
Cottonwood	227	220	—	7	—
Total	386	379	(1)	7	—
All species	22,632	17,552	4,357	673	50

[1] *Less than 0.5 million board feet.*

Table 14b.—Volume of sawtimber on commercial forest land by Scribner log rule, species, and diameter groups, Wyoming, 1960

Species	Diameter group (inches at breast height)				
	All classes	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million board feet				
Softwoods:					
Douglas-fir	3,054	1,798	1,016	225	15
Ponderosa pine	1,641	1,493	145	3	—
Lodgepole pine	4,874	4,652	208	14	—
Whitebark and limber pine	1,052	908	131	9	4
White fir	1	1	(1)	—	—
Subalpine fir	1,292	1,168	122	2	—
Engelmann spruce	7,165	4,529	2,264	346	26
White spruce	11	11	—	—	—
Other softwoods	—	—	—	—	—
Total	19,090	14,560	3,886	599	45
Hardwoods:					
Aspen	132	132	(1)	—	—
Cottonwood	191	185	—	6	—
Total	323	317	(1)	6	—
All species	19,413	14,877	3,886	605	45

[1] *Less than 0.5 million board feet.*

Table 15.—Volume of sawtimber on commercial forest land, by species[1] and quality classes, Wyoming, 1960

Species	All classes	Quality classes 1	2	3	4
	Million board feet[2]				
Softwoods:					
Ponderosa pine[2]	2,072	44	164	535	1,329
Total	2,072	44	164	535	1,329

[1] *Ponderosa pine is the only species graded.*
[2] *International ¼-inch rule.*

Table 16.—Volume of salvable dead sawtimber-size trees on commercial forest land, by softwoods and hardwoods, Wyoming, 1960

Species group	Volume
	Thousand board feet[1]
Softwoods	3,554,561
Hardwoods	39,911
All species	3,594,472

[1] *International ¼-inch rule.*

Table 17.—Net annual growth and annual cut of growing stock on commercial forest land, by species, Wyoming

Species	Net annual growth, 1960	Annual timber cut, 1962
	Thousand cubic feet	
Softwoods:		
Douglas-fir	7,490	1,007
Ponderosa pine	14,463	3,990
Lodgepole pine	33,294	12,954
True firs	4,344	552
Spruce[1]	19,828	3,230
Other softwoods	5,484	8
Total	84,903	21,741
Hardwoods	412	15
All species	85,315	21,756

[1] *Engelmann and white spruces.*

Table 18.—Net annual growth and annual cut of sawtimber on commercial forest land, by species, Wyoming

Species	Net annual growth, 1960	Annual timber cut, 1962
	Thousand board feet[1]	
Softwoods:		
Douglas-fir	16,443	5,706
Ponderosa pine	49,542	22,824
Lodgepole pine	40,436	73,902
True firs	−10,697	3,101
Spruce[2]	84,145	18,483
Other softwoods	13,039	31
Total	192,908	124,047
Hardwoods	−7,875	9
All species	185,033	124,056

[1] *International ¼-inch rule.*
[2] *Engelmann and white spruces.*

Table 19.—**Net annual growth and annual cut of growing stock on commercial forest land, by ownership classes and by softwoods and hardwoods, Wyoming**

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
NET ANNUAL GROWTH, 1960 *(Thousand cubic feet)*				
Softwoods	84,903	60,116	7,356	17,431
Hardwoods	412	3,518	−708	−2,398
All species	85,315	63,634	6,648	15,033
ANNUAL TIMBER CUT, 1962 *(Thousand cubic feet)*				
Softwoods	21,741	19,415	1,304	1,022
Hardwoods	15	13	1	1
All species	21,756	19,428	1,305	1,023

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 20.—**Net annual growth and annual cut of sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Wyoming**

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
NET ANNUAL GROWTH, 1960 *(Thousand board feet)*[2]				
Softwoods	192,908	120,174	22,286	50,448
Hardwoods	−7,875	−546	−1,691	−5,638
All species	185,033	119,628	20,595	44,810
ANNUAL TIMBER CUT, 1962 *(Thousand board feet)*[2]				
Softwoods	124,047	110,774	7,443	5,830
Hardwoods	9	8	1	—
All species	124,056	110,782	7,444	5,830

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *International ¼-inch rule.*

Table 21.—**Annual mortality of growing stock and sawtimber on commercial forest land, by species, Wyoming, 1960**

Species	Growing stock	Sawtimber
	Thousand cubic feet	*Thousand board feet*[1]
Softwoods:		
Douglas-fir	5,833	25,405
Ponderosa pine	3,518	11,728
Lodgepole pine	13,444	39,956
True firs	11,406	39,347
Spruce[2]	2,587	13,627
Other softwoods	1,577	7,360
Total	38,365	137,423
Hardwoods	10,490	14,884
All species	48,855	152,307

[1] *International ¼-inch rule.*

[2] *Engelmann and white spruces.*

Table 22.—**Annual mortality of growing stock and sawtimber on commercial forest land by ownership classes, and by softwoods and hardwoods, Wyoming, 1960**

Ownership class	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Thousand cubic feet			*Thousand board feet*[1]		
National Forest lands	34,730	33,277	1,453	126,582	123,338	3,244
Other public lands	4,320	2,194	2,126	8,220	5,510	2,710
Farmer and miscellaneous private lands[2]	9,805	2,894	6,911	17,505	8,575	8,930
All ownerships	48,855	38,365	10,490	152,307	137,423	14,884

[1] *International ¼-inch rule.*

[2] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 23.—**Annual mortality of growing stock and sawtimber on commercial forest land, by causes and by softwoods and hardwoods, Wyoming, 1960**

Cause of death	Growing stock			Sawtimber		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	Thousand cubic feet			*Thousand board feet*[1]		
Fire	1,339	1,339	—	4,675	4,675	—
Insects	12,057	11,813	244	47,818	47,541	277
Disease	20,627	10,580	10,047	50,233	36,244	13,989
Other	6,703	6,614	89	24,944	24,617	327
Unknown	8,129	8,019	110	24,637	24,346	291
All causes	48,855	38,365	10,490	152,307	137,423	14,884

[1] *International ¼-inch rule.*

Table 24.—Total output of timber products, by products, by type of material used, and by softwoods and hardwoods, Wyoming, 1962

Product and species group	Total output in standard units		Output from roundwood from growing stock		Output from roundwood from nongrowing stock sources		Output from plant by-products (standard units)
	Unit	Number	Standard units	M cubic feet	Standard units	M cubic feet	
Saw logs:							
Softwood	M bd. ft.[1]	116,523	114,193	19,225	2,330	392	0
Hardwood	M bd. ft.[1]	0	0	0	0	0	0
Total	M bd. ft.[1]	116,523	114,193	19,225	2,330	392	0
Pulpwood:							
Softwood	M std. cords[2]	16	3	334	1	130	12
Hardwood	M std. cords[2]	0	0	0	0	0	0
Total	M std. cords[2]	16	3	334	1	130	12
Mine timber:							
Softwood	M cu. ft.	54	21	21	33	33	0
Hardwood	M cu. ft.	0	0	0	0	0	0
Total	M cu. ft.	54	21	21	33	33	0
Misc. Industrial wood:[3]							
Softwood	M cu. ft.	426	335	335	91	91	0
Hardwood	M cu. ft.	15	15	15	0	0	0
Total	M cu. ft.	441	350	350	91	91	0
Posts:							
Softwood	M pieces	79	48	48	31	31	0
Hardwood	M pieces	0	0	0	0	0	0
Total	M pieces	79	48	48	31	31	0
Fuelwood:							
Softwood	M std. cords	3	0	11	1	98	2
Hardwood	M std. cords	0	0	0	0	0	0
Total	M std. cords	3	0	11	1	98	2
All products:							
Softwood	M cu. ft.	—	—	19,974	—	775	—
Hardwood	M cu. ft.	—	—	15	—	0	—
Total	M cu. ft.	—	—	19,989	—	775	—

[1] *International ¼-in rule.*
[2] *Rough wood basis (for example, chips converted to equivalent standard cords).*
[3] *Includes mainly house logs and turnery bolts.*

Table 25.—Total output of roundwood products, by source and by softwoods and hardwoods, Wyoming, 1962

Source	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Growing-stock trees:[1]			
Sawtimber trees	16,598	16,598	0
Poletimber trees	3,391	3,376	15
Total	19,989	19,974	15
Cull trees	84	84	0
Salvable dead trees[1]	691	691	0
Other sources[2]	0	0	0
All sources	20,764	20,749	15

[1] *On commercial forest land.*

[2] *Includes noncommercial forest land, nonforest land such as fence rows, trees less than 5.0 inches in diameter, and treetops and limbs.*

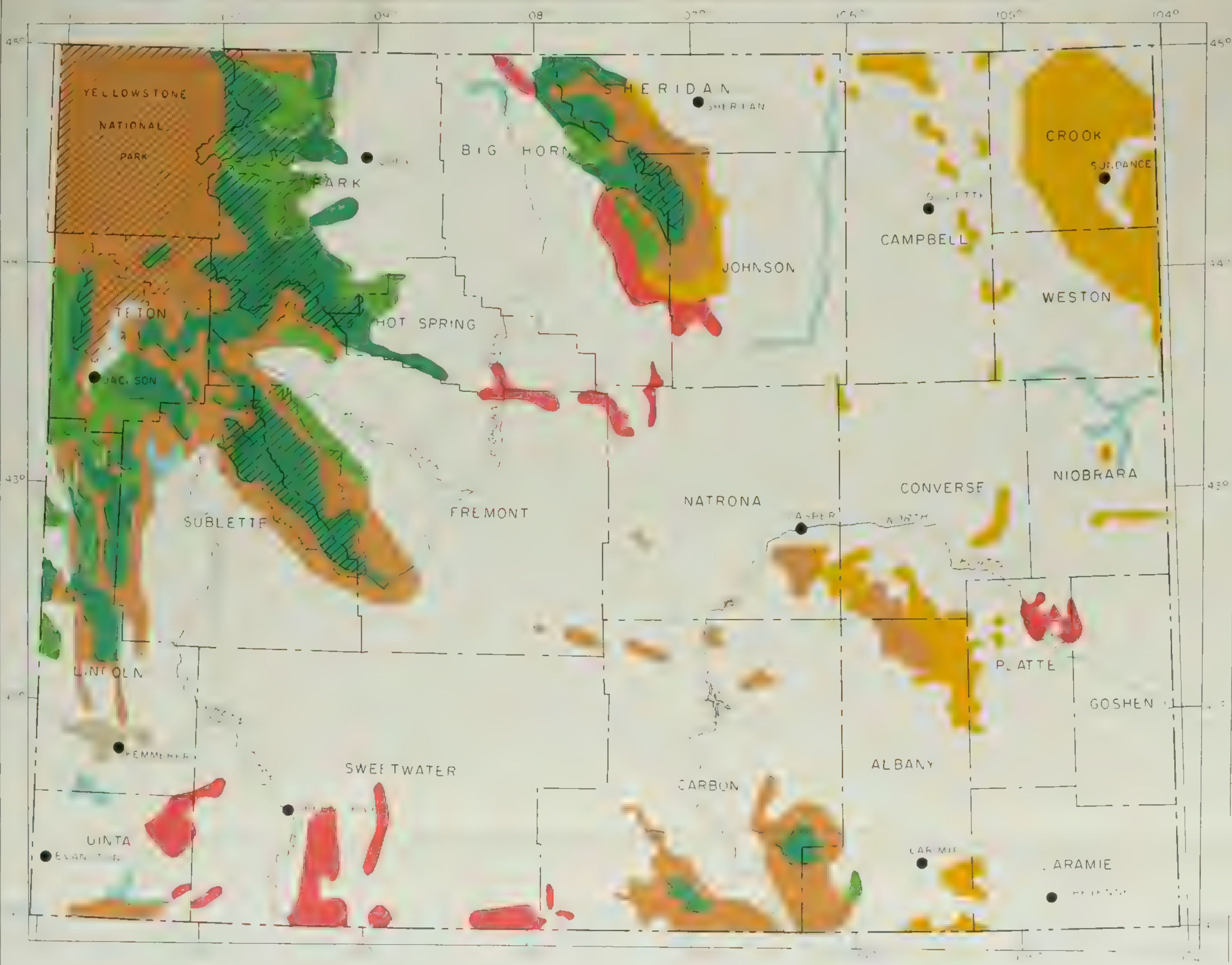
Table 26.—Annual timber cut from growing stock on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Wyoming, 1962

Products and residues	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Roundwoods products:			
Saw logs	19,225	19,225	0
Pulpwood	334	334	0
Mine timbers	21	21	0
Misc. industrial wood	350	335	15
Posts	48	48	0
Fuelwood	11	11	0
All products	19,989	19,974	15
Logging residues	1,767	1,767	0
Timber cut	21,756	21,741	15

Table 27.—**Annual timber cut from live sawtimber on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Wyoming, 1962**

Products and residues	All species	Softwoods	Hardwoods
	Thousand board feet[1]		
Roundwood products:			
Saw logs	114,193	114,193	0
Pulpwood	1,739	1,739	0
Mine timbers	33	33	0
Misc. industrial wood	199	190	9
Posts	143	143	0
Fuelwood	4	4	0
All products	116,311	116,302	9
Logging residues	7,745	7,745	0
Timber cut	124,056	124,047	9

[1] *International ¼-inch rule.*



MAJOR FOREST TYPES
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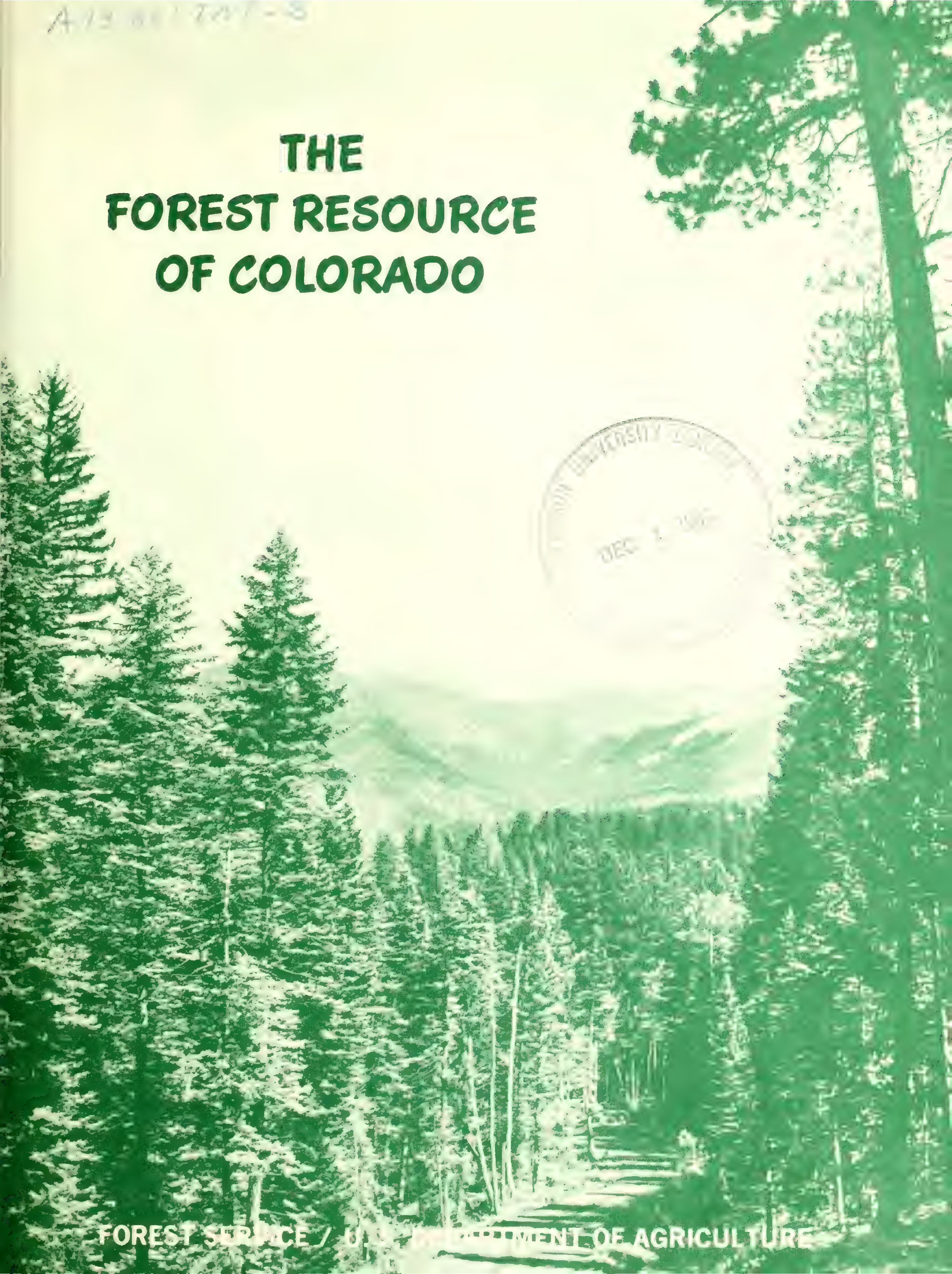

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FOREST SERVICE / U.S. DEPARTMENT OF AGRICULTURE

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* * * * *

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COVER PHOTO

Timber and recreation resources on the San Juan National Forest in southern Colorado. The forest in the foreground is a sawtimber stand with Douglas-fir as the principal species. Part of the 239,000 acres of the San Juan Primitive Area appears in the mountains in the background.

U. S. FOREST SERVICE RESOURCE BULLETIN INT-3 1964

THE FOREST RESOURCE OF COLORADO

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FOREST SERVICE — U. S. DEPARTMENT OF AGRICULTURE

FOREWORD

This report is concerned primarily with the timber resource. However, because practically none of the forest area is managed for timber alone, the report also briefly describes demands for associated forest values — water, recreation, wildlife, and forage.

Timber inventory data in the report are from the first comprehensive survey of Colorado's forest resources. The survey was conducted as part of the continuing nationwide Forest Survey. Fieldwork started in 1956 and was completed in 1959. The survey was done on a cooperative basis by the Intermountain Forest and Range Experiment Station, Ogden, Utah, the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, and the Rocky Mountain Region, Denver, Colorado. Field sampling and compilation were done by the Intermountain Station, and mapping by the Rocky Mountain Region.

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STATISTICAL HIGHLIGHTS[1]

FOREST AREA

- Colorado has 22.6 million acres of forest land. This is about one-third of the area of the State.
- 12.3 million acres are commercially important for timber production.
- 9.1 million acres or about 75 percent of the commercial forest area is in public ownership. About 92 percent of the public lands are in National Forests.
- About 52 percent of the commercial forest is in sawtimber stands.[2] These stands average 7,317 board feet per acre.[3]
- Fir-spruce is the biggest type and covers about 28 percent of the commercial forest area.

TIMBER VOLUME

- Colorado's commercial forests have 17.3 billion cubic feet of wood in sound, live trees, and 52.7 billion board feet in sawtimber trees.
- About 85 percent of the volume is in public ownership.
- 72 percent of the cubic-foot volume in sound, live trees is in sawtimber stands.
- About 93 percent of the board-foot volume of sawtimber is in softwood trees and more than one-half of this is Engelmann spruce.

STAND CONDITIONS

- The net annual growth of sawtimber is about 1 percent of the sawtimber inventory.
- One out of five trees of sawtimber size in the commercial forest is either cull or salvable dead.
- Insects and diseases cause more than 80 percent of the annual mortality.

TIMBER USE

- In 1962 Colorado's total timber cut was only 0.22 percent of the State's cubic-foot volume of sound live trees. This is one-third the cutting rate for the Mountain States.
- Saw logs intended for lumber accounted for 87 percent of the volume of primary timber products in 1962.
- Almost one-half of the 208 million board feet[4] of lumber produced in Colorado in 1962 (*17*) was Engelmann spruce.
- Lumber production increased about 11 percent between 1957 and 1962, but the number of active sawmills declined from 274 to 170 in the same period.

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[1] *This survey indicates that Colorado has almost 1.5 times the commercial forest area and more than twice the live sawtimber volume that was reported for 1952 by "Timber Resources for America's Future" (15). (Italic numbers in parentheses indicate numbered references on page 35). Actual changes in forest stand conditions are believed minor. The most recent figures are based on a statistically designed survey, whereas the previous estimates were not. Also, because of changed utilization standards, a large area formerly classed as unproductive is now considered to be productive and is classified as commercial forest.*

[2] *Stands containing at least 1,500 board feet of sawtimber per acre.*

[3] *International ¼-inch log rule board-foot volumes are used throughout this report unless otherwise stated.*

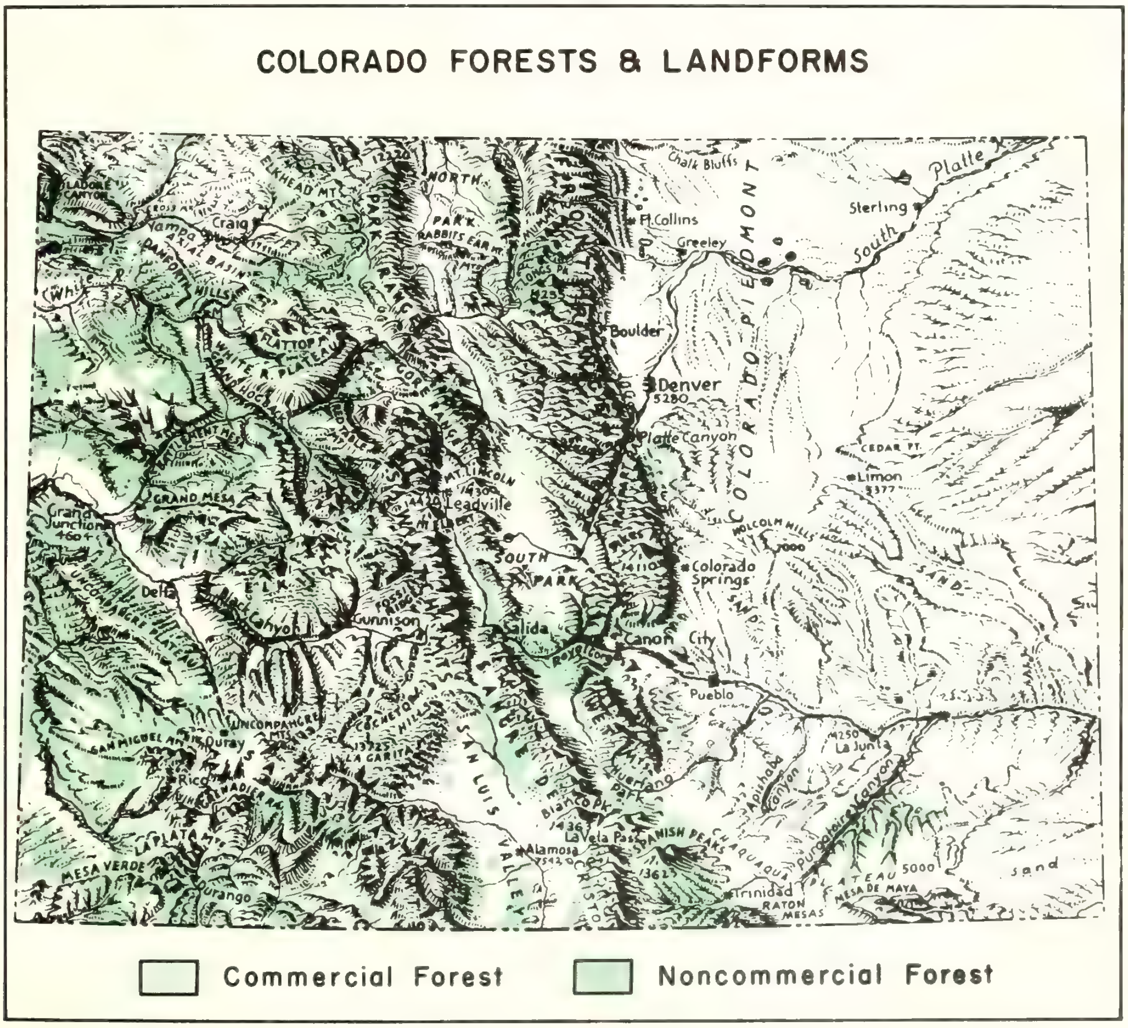
[4] *Lumber tally.*

COLORADO FORESTS

Colorado's famous landforms have made the State's forests unique in kind and distribution. As has been so aptly pointed out, "The second mile up is forested" (*4*).

The rolling, almost treeless eastern plains of Colorado tilt upward to the west; at about a mile above sea level in the middle of the State they give way to the timbered front ranges of the Continental Divide. A complex of forested mountain ranges, mesas, and plateaus interspersed with nontimbered valleys, foothills, and low ranges extends to the western border.

Below 5,500 feet, vegetation is largely grass or salt-desert shrubs. These cover types blend into sagebrush, oakbrush, pinyon pine, and juniper at about 5,500 to 6,500 feet. Under the more favorable moisture conditions at higher elevations, forest stands of commercial timber quality take over. Ponderosa pine, Douglas-fir, aspen, lodgepole pine, spruce, and fir types occur in that general succession up



Adapted from "Map of the Land Forms of the United States" by Erwin Raisz.

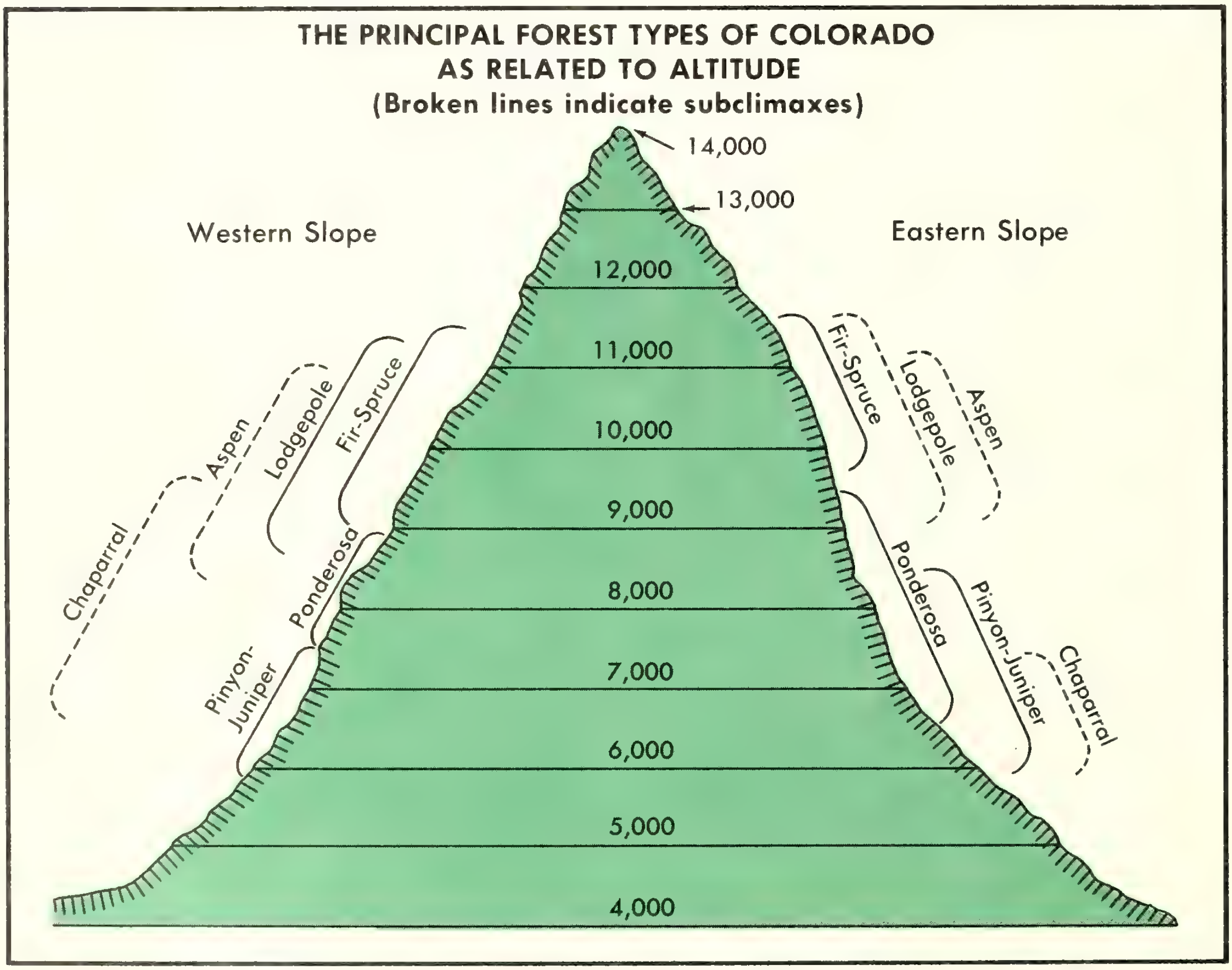
to timberline at about 11,500 feet.

Extreme climatic and physiographic differences in Colorado cause correspondingly large differences in growing conditions and therefore in tree size and quality as well as species. Not only are there local variations in forest characteristics, but there are also variations from one part of the State to another. Geographical differences are especially noticeable when ponderosa pine, Douglas-fir, and Engelmann spruce trees in the more favored southwestern part of the State are compared with those in less productive areas.

Of the State's 22.6 million acres of forest, only a little more than one-half is commercially important for timber production. The rest is classed as noncommercial and consists of lands reserved from timber cutting and sites that cannot grow trees of commercial size and quality. Much of the noncommercial forest occurs under the unfavorable growing conditions above and below the predominantly commercial zone, but there are also many areas of noncommercial forest within this zone. The following tabulation shows the area of major classes of forest.

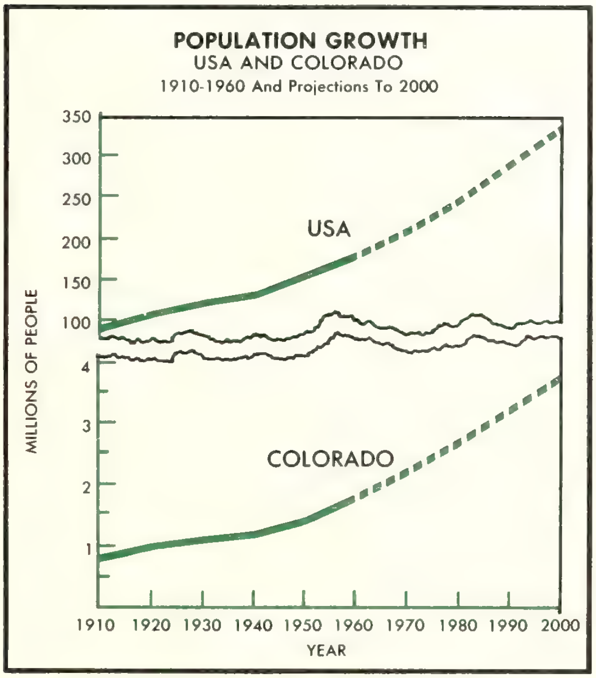
	Thousand acres
Commercial forest land	**12,275**
Noncommercial forest land:	
Productive, reserved from timber use	**465**
Unproductive	**9,843**
Total	**22,583**

The general range in elevation of most of the principal forest types on western and eastern slopes is shown schematically below. There are many local variations from this general situation because of differences in soils, precipitation, exposure, and other environmental factors.



Adapted from "The Principal Forest Types of Colorado as related to Altitude" by Herbert E. Schwan.

Although Colorado's forests cover only about one-third of the area of the State and are remote from the activities of most of the people, they are some of the most important lands in the State. Their importance to the State and the Nation lies in their multiple values — water, timber, recreation, wildlife, and livestock forage. In recent years, population growth has placed greatly increased demands on most of these forest benefits; past and projected future population increases are shown in the chart below.



Sources: U.S. Bureau of the Census and Select Committee on National Water Resources, U.S. Senate, 86th Congress.

Demand for water from the forests is intense

None of Colorado's many natural resources is in greater demand than water. The major role of forest lands in meeting this demand is evident from the estimate that about 85 percent of the State's annual runoff originates from the mountain forests and areas above timberline (*10*).

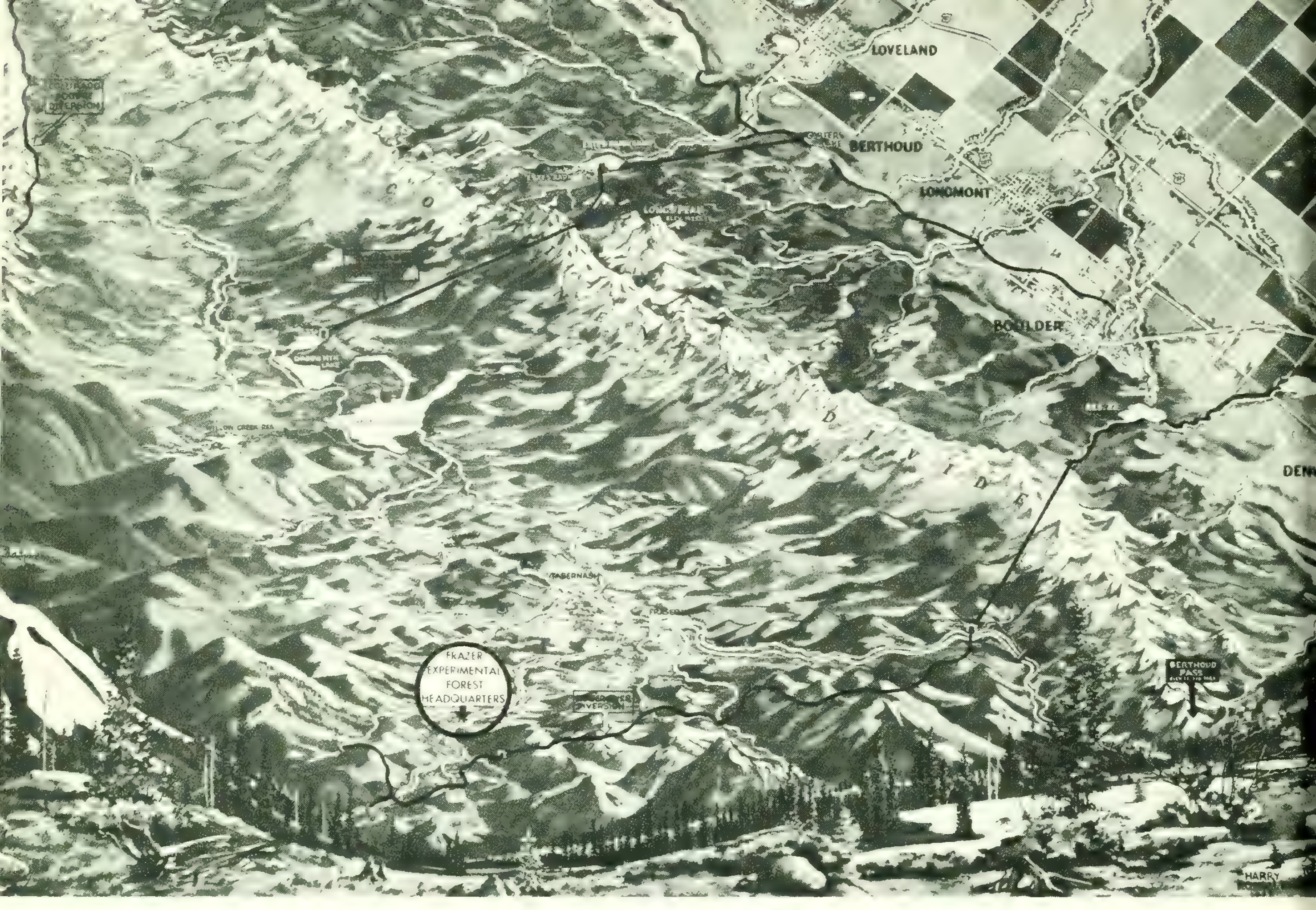
Competition for Colorado water is very keen among downstream States. About one-half of Colorado's annual runoff of 16 million acre feet leaves the State. Some Colorado water flows thousands of miles — to the Gulf of Mexico via the North and South Platte, Arkansas, Rio Grande and other rivers, and to the Gulf of California via the Colorado River. The waters of Colorado's major rivers and aquifers flow in or to no less than 18 States and are of significant economic value to at least eight of them.

The best example of high intensity of demand is the Colorado River, which heads at the Continental Divide just west of Denver and flows through arid lands of Utah, Arizona, Nevada, California, and Mexico. Allocation of Colorado River water among these States for agricultural, industrial, and culinary use has been the subject of some of the most intense interstate controversies and litigations in recent times. As stated by an official concerned with Colorado River development:

> Probably nowhere are problems more difficult and extraordinary, water more priceless, and rights to its use defended more vigorously than in planning and developing the Colorado. This is exemplified by the tremendous control and use structures on the lower Colorado River. Tremendous is the growth of agriculture and industry in the farming areas of Yuma, Imperial, and Salt River Valleys and in or about the metropolitan districts of Los Angeles, San Diego, Henderson, and Phoenix . . . (*9*).

The high value of Colorado water in faraway places is indicated by the level and trend of use in Los Angeles. The Metropolitan Water District of Los Angeles, with an area of 3,018 square miles and more than 6.5 million people, was using Colorado River water at the rate of 405,961 acre feet a year in 1957. According to an estimate for that year, "While it is now delivering about 5 percent of the area's water supply, it is expected the Colorado River will provide about 50 percent by 1970. With these increased demands, the Colorado River is of key importance to the future growth of the metropolitan area" (*12*).

The projected increase in water use with a bigger population and greater industrial development portends very heavy future demands



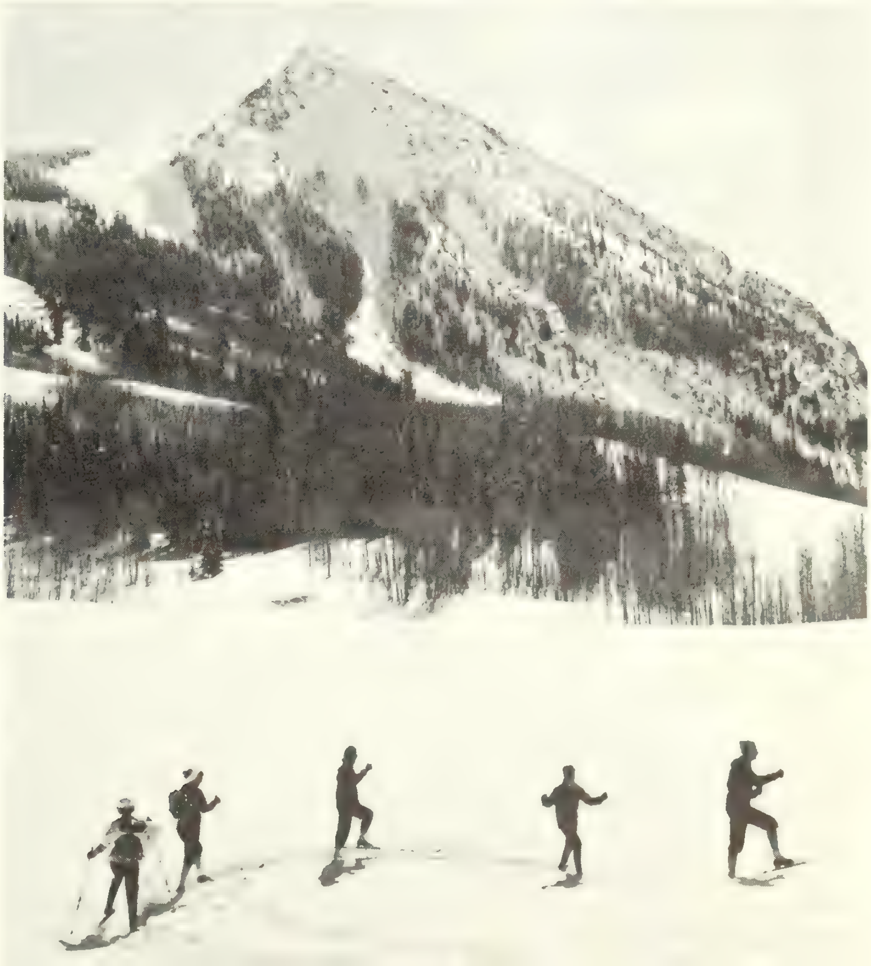
The vast transmountain water diversions of central Colorado, including the Colorado-Big Thompson, Fraser River, and part of the Colorado-Poudre systems are illustrated above. The diversion structure pictured is on the Cache la Poudre River, lying to the north of the area represented on the schematic illustration. This structure diverts water from the river by tunnel and canal to storage reservoirs for irrigation purposes.

on the Colorado forest watershed. Availability of water will be a major limiting factor in the long-term economic development of Colorado, where industry and population are basically dependent on the forested watershed. Colorado is already using its entire surface rights — 7.6 million acre feet a year. In addition, about 2 million acre feet of ground water is used annually. Almost 95 percent of the total water use is for irrigation. In areas where municipal demand is increasing, annual use is nearly equal to replacement supply; therefore future expansion of municipal (and industrial) use in these areas must be provided for by reuse or through a decrease in irrigation (*6*). Major projects to store and transfer water have been undertaken in Colorado. The latest of these are the Fraser River and the Colorado-Big Thompson transmountain diversions that transfer water from the Colorado River headwaters through the Continental Divide by tunnel to Denver and eastern Colorado (illustrated on page 4), and the Curicanti Reservoir now under construction on the Gunnison River.

Forest recreation use has increased fourfold in the last 10 years

More people come in direct contact with the forest through recreation activities than through any other use. In Colorado a high proportion of the recreationists come from out-of-State, apparently attracted by the unexcelled summer climate, outstanding mountain and forest scenery, wide variety in recreation, and accessibility of the forests, many of which are crossed by main transcontinental travel routes and transportation facilities.

Outdoor recreation activity in many forms has burgeoned throughout Colorado's 22.6 million acres of forest. To meet this demand public land agencies — State and Federal — have developed expanding programs to provide a full range of outdoor recreation. About 465,000 acres of productive timberland has been set aside from timber use to protect scenic and wilderness values. Almost all of these lands lie in National Parks and in 10

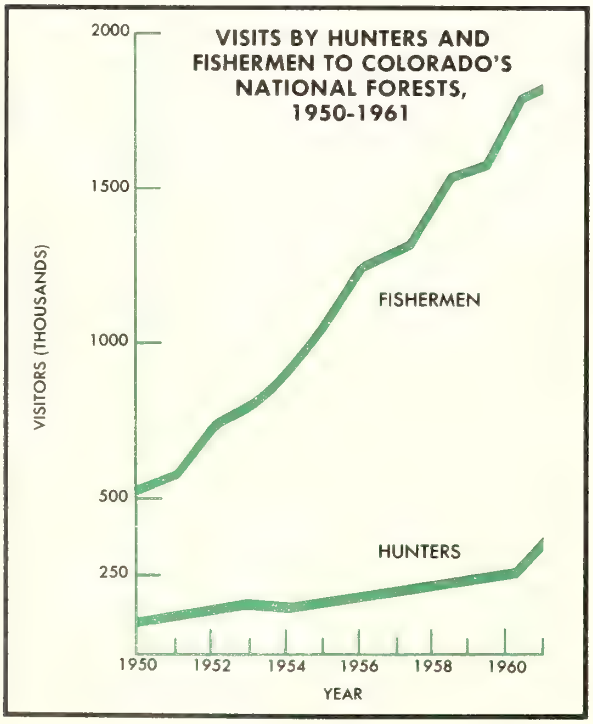


Cross-country skiers at the foot of Crested Butte Mountain, Crested Butte Winter Sports Area, Gunnison National Forest.

wild, primitive, and wilderness areas within National Forests.

The increase in recreation use is indicated by the following comparison: In 1962 the National Forests of Colorado received more than 12 million visits for recreation — about four times the 1952 figure. This rate of increase is about the same as the national trend. Colorado ranks second only to California in recreation visits to National Forests and receives almost 10 percent of the total for all National Forests in the country. Forest lands also provide much of the attraction for visitors to the State's numerous private developments — dude ranches, fishing and hunting lodges, and so forth. Although the value of recreation is difficult to compare with that of other forest uses, there is little question that in the long run it will be one of the most important uses of Colorado's forests.

Fish and game resources of Colorado's forests provide a highly important recreation use. The following chart indicates to some extent the spectacular increase in recent years in the numbers of fishermen using the many lakes and streams within Colorado's forests.



The rate of increase in hunter use is considerably less. Colorado, however, ranks among the five leading States in mule deer and elk populations and harvest. Game populations in 1955 were estimated at 56,000 elk, 325,000 mule deer, 5,100 bighorn sheep, and 12,000 wild turkey (*18*). Except for mule deer, harvest of each of the forest game species in the State has not changed much from year to year during the last decade. Although the mule deer harvest has shown a general increase over the years, there has been considerable annual fluctuation. The harvest was 65,200 in 1950, and a record of 147,848 in 1963. The elk harvest of 12,120 head in 1963 was also a record.

Extensive areas of pinyon-juniper and chaparral and some of the commercial forest areas are valuable for game and livestock range

Colorado's 8.4 million acres of pinyon-juniper and chaparral lands have been classified as noncommercial from the standpoint of timber production. As shown in the following tabulation these types make up the bulk of the noncommercial forest in the State.

	Thousand acres
Pinyon-juniper	**4,674**
Chaparral[1]	**3,704**
Other	**1,930**
All types	**10,308**

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[1] *Includes Gambel oak, mountain mahogany, serviceberry, and other woody species.*

Some of the better chaparral lands are being planted to ponderosa pine and are thus being converted to commercial forest. However, the preponderance of the State's noncommercial forest will continue to be used chiefly for domestic livestock grazing and game habitat.

These areas are particularly important as winter range for mule deer and elk. High elevation game ranges, consisting principally of the commercial forests and small areas of mountain meadow and nonforested alpine country, are used in the summer and fall when free of snow. The good interspersion of vegetation types in western Colorado is probably the most important single factor contributing to the high populations of deer and elk. Commercial and noncommercial forests and intermixed nonforest areas complement each other, providing year-round game range.

Domestic livestock grazing was one of the earliest uses of Colorado's forests and continues to be important. While no specific information is available on the contribution of the forest ranges to the State's livestock production, it was estimated in 1957 that the mountain range livestock industry included 49 percent of the State's total cattle and sheep numbers, and had an income of about $146 million (10-year average, 1945-55) (*3*).

Gambel oak stands like this one in southwestern Colorado cover extensive areas of mesa tops and slopes in the western part of the State. They make up a major part of the chaparral type. These lands are chiefly useful for domestic livestock and game range. Many such areas present a problem in conversion of the land to better use.

In 1962 about 149,000 cattle and 490,000 sheep grazed on the National Forests. The forest ranges provide a large part of the total mountain range capacity, probably more than 50 percent. At least three-fourths of the forest range is west of the Continental Divide. Aspen, followed by ponderosa pine, chaparral,[5] and pinyon-juniper, are the leading types in forage productivity — in both yields per acre and in total production from the type.

In addition to the aspen and ponderosa pine lands, areas valuable for forage within the general commercial forest zone are interspersed mountain meadows, other natural nontimbered areas, and nonstocked or partially stocked cutover areas and burns.

After reaching a peak at the end of World War I, the number of cattle and sheep grazed on National Forests gradually declined. Most reductions were made to bring use in line with the range capacity. Range management and improvement practices have been greatly intensified in recent years. Forage production is being increased by control of undesirable plants with herbicides, by better control of stocking, and in some areas by rotation and deferred grazing practices. The potential for improvement is great, and the outlook is for more intensive management and stabilization of use on the better ranges.

The benefits or economic returns from grazing are difficult to compare with those from other land uses. However, it is clear that grazing has an important place in multiple use management of the forest lands in Colorado. Forest and other wild land grazing areas are significant complements to the highly productive valley hay meadows, irrigated pastures, and other resources of the specialized mountain range livestock industry.

Timber cut should be accelerated

Although timber cutting has gone on since pioneer days and more than half of Colorado's forests are of commercial quality, present timber use is somewhat a stepchild among the various uses of the forest. In contrast to water, recreation, and grazing, which are rapidly approaching, or have nearly reached capacity under present management throughout the State, there are still extensive timbered areas that have not been tapped.

Despite the fact that Colorado's timber cut for lumber has more than doubled since 1940, the present timber cut for saw logs (about 178 million board feet) is far below the cut that is allowable and desirable under good management practice. Difficult access to much of the timberland and inadequate markets for Colorado timber have retarded utilization; more than one-half of the sawtimber stands are overmature virgin timber.

Desirable qualities of the wood, as well as the large untapped volume, favor industrial development of the timber resource. Slow growth rates combined with satisfactory wood characteristics result in exceptionally even-textured woods with a high strength-to-weight ratio. If markets can be developed, there are excellent opportunities for integrated operations producing lumber, pulpwood, composition board, railroad ties, poles, and other products.

A cash return is not the only benefit that can result from accelerated timber harvesting. On public lands the effect of timber cutting on other forest values is being considered more and more. As discussed later in this report, water, recreation, and wildlife management can be improved in many areas when these multiple values are considered in timber cutting.

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[5] *Assumed to be about the same in productivity as the mountain brush range type.*

COMMERCIAL FORESTS

Difficult mountain terrain has hindered access, and has been a retarding factor in the development and management of Colorado's commercial forest. The commercial forest occurs on three major mountainous landforms. About 60 percent is on steep slopes of high mountain ranges where logging problems are particularly difficult. The trees are mainly spruce, fir, lodgepole pine, and Douglas-fir.

About 15 percent of the commercial forest is perched high on tablelands — plateaus and mesas. Although these are relatively flat, some are difficult to reach and far from main transportation systems and industrial centers. Timber types in tablelands are fir-spruce and aspen, and in more limited areas lodgepole and ponderosa pine. Tableland forests generally have high volumes per acre in virgin sawtimber stands and are considered above average in potential timber productivity. Tablelands are also valuable for domestic livestock and game range.

The remaining 25 percent of the commercial forest lies in rolling mountainous country at intermediate altitudes. Slopes are moderate to steep, although relatively short. Lodgepole pine, ponderosa pine, aspen, and Douglas-fir types predominate. These are the most accessible lands within the commercial forest and as a result have been largely cutover. Furthermore, recreation use and human contact in general are more intense in these areas.

Tabulations below summarize some of the important statistics relating to the commercial forest:

Forest type	*Million acres*
Fir-spruce	3.4
Ponderosa pine	2.3
Lodgepole pine	2.1
Douglas-fir	1.5
Aspen	2.8
Limber and bristlecone pine	.1
Cottonwood	.1
Total	12.3

Principal species	*Billion cubic feet*[1]
Engelmann spruce	6.2
True firs	2.4
Ponderosa pine	1.0
Lodgepole pine	3.3
Douglas-fir	1.6
Aspen	2.4
Other	.4
Total	17.3

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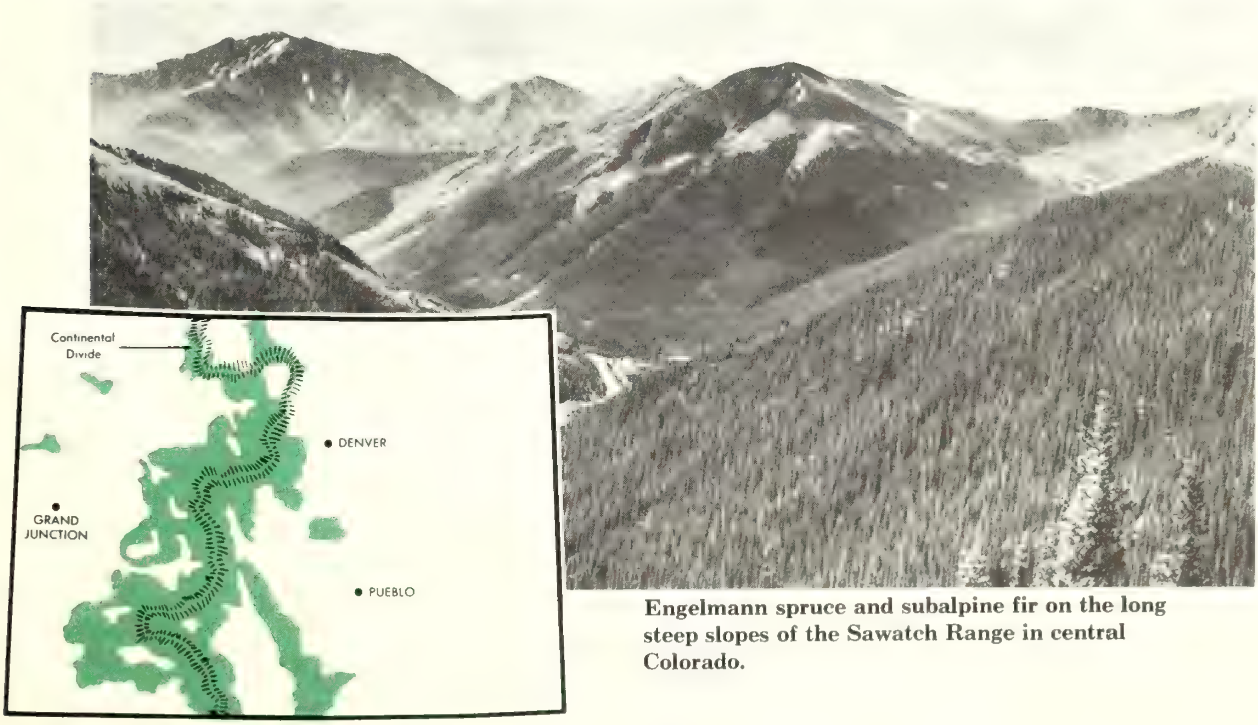
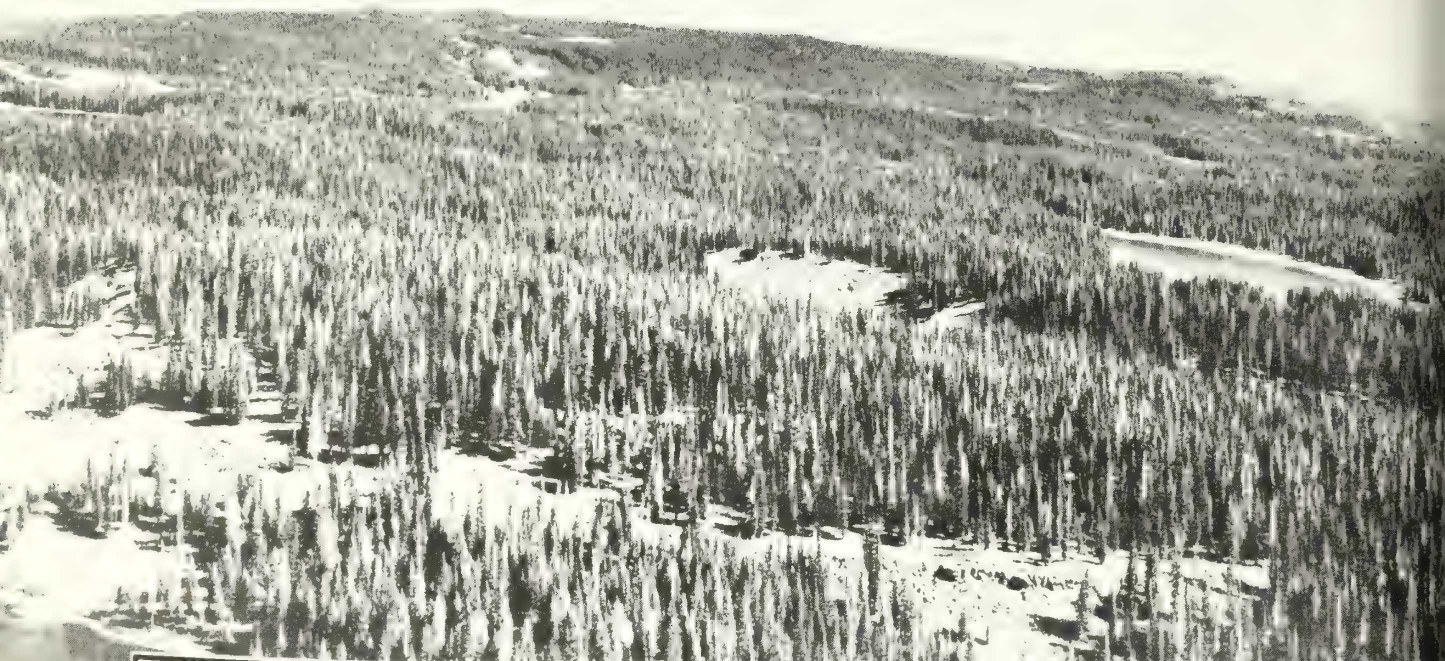
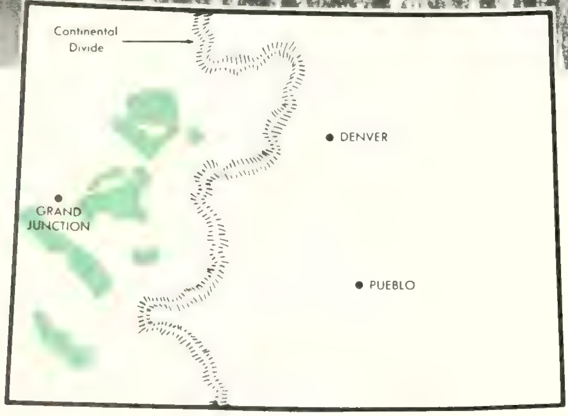
[1] *Live noncull trees 5.0 inches d.b.h. and larger.*

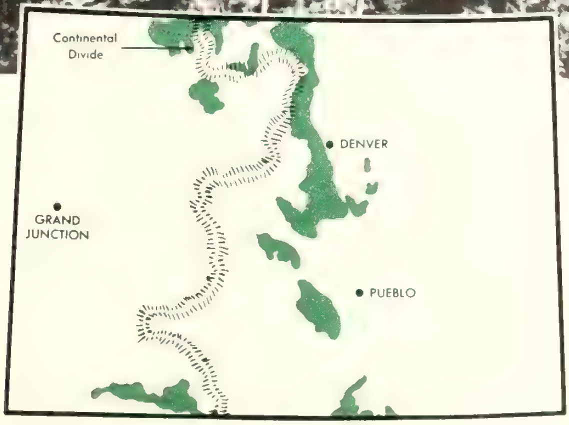


Engelmann spruce and subalpine fir on the long steep slopes of the Sawatch Range in central Colorado.

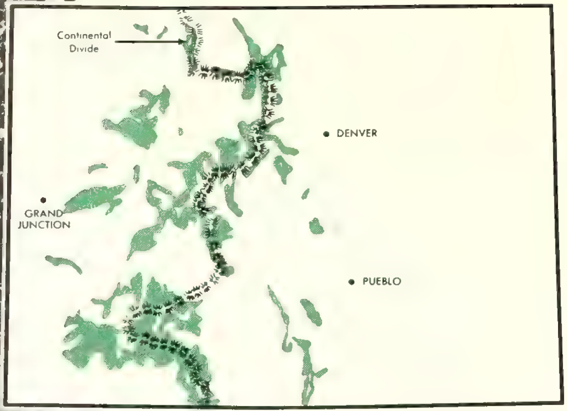




Forests on tablelands vary greatly in species composition and other stand characteristics. The photo above shows a stand of Engelmann spruce on Grand Mesa. Ponderosa pine stands on the Uncompahgre Plateau, across the Gunnison Valley about 50 miles southwest of this area, are a quite different type of tableland forest.



The forest shown above — lodgepole pine and Engelmann spruce on the Routt National Forest in southeastern Jackson County — is representative of timberlands on rolling mountain terrain at intermediate elevations.



The Fir-Spruce Forest

	Thousand acres
Sawtimber	2,746
Poletimber	485
Seedling-sapling	27
Nonstocked	135
Total	3,393

These Engelmann spruce of large sawtimber size are about 125 feet in height, 200 years old, and range from 22 to 26 inches d.b.h. This stand is on the San Juan National Forest — an exceptionally good area for Engelmann spruce in Colorado.

Fir-spruce[6] is the most important commercial forest type

Spruce and true fir forests are the major timber resource in Colorado. About 28 percent of the commercial forest area is in the fir-spruce type. Engelmann spruce is the most important tree from the standpoint of timber volume in the fir-spruce type, as well as in the commercial forest as a whole. Almost one-half of Colorado's sawtimber volume and about 36 percent of the cubic volume in sound live trees 5.0 inches and larger is Engelmann spruce.

Important factors contributing to the high productivity of Engelmann spruce are its ability to sustain a good rate of growth (for mountain species) through a relatively long life and its habit of growing in the wettest climatic zone. The fir-spruce forests are located mainly on mountain slopes and on Grand Mesa and the White River Plateaus in western Colorado at elevations of about 10,000 to 11,500 feet — the zone of heaviest precipitation.

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[6] *Fir-spruce is a recognized general western type group and is not separated into spruce and fir type acreages in the Forest Survey. Acreages shown for this type are largely for areas on which Engelmann spruce, subalpine fir, or both species, predominate. Although white fir is not usually an associate of these species, the relatively minor area on which it predominates has been included in the fir-spruce acreage in this report. White fir volumes are reported under true firs.*

The designation spruce-fir was used for this type by Forest Survey until recent years, and is still used by many foresters.

Engelmann spruce trees are in general the biggest in Colorado's commercial forest. The following tabulation shows present average volume per sawtimber tree of Colorado's principal sawtimber species:

	Board feet
Engelmann spruce	**209**
True firs	**137**
Lodgepole pine	**128**
Douglas-fir	**131**
Aspen	**120**
Ponderosa pine	**103**

The average diameter of spruce sawtimber trees is somewhat greater than of other species listed above, and trees are generally much taller. Mature spruce sawtimber trees vary from two to five logs[7] in merchantable height through most of the range, but grow to a height of as much as eight logs on parts of the San Juan National Forest in the southwestern part of the State, where the species reaches its best development in Colorado. Stands can be found in this area containing more than 50,000 board feet per acre.

In recent years access to Colorado's Engelmann spruce forests has improved and there has been a marked increase in acceptance of the species for lumber. Since about 1950 it has been the leading species for lumber production. In 1962 the Engelmann spruce saw log cut of about 89 million board feet amounted to almost one-half the State's output for all species. In Colorado, Engelmann spruce wood is particularly even-textured with a relatively high strength-to-weight ratio. Although now used almost entirely for lumber, Engelmann spruce is well suited for pulp, plywood, and other uses. Its resistance to preservative treatment has limited its use for commercial production of treated products.

Engelmann spruce usually grows in even-aged stands and frequently in mixture with other species. Probably at least two-thirds of the type in Colorado is in overmature virgin stands. Extensive areas of this old-growth timber make Engelmann spruce highly vulnerable to insects. Catastrophic outbreaks of Engelmann spruce beetles during the period 1939-55 killed all the Engelmann spruce on at least 261,000 acres of sawtimber stands in western Colorado. The threat of further outbreaks greatly complicates problems of harvesting and regenerating old-growth areas. In fact, development of techniques that will keep a lid on the insect population and still permit successful harvesting and subsequent regeneration of spruce is one of the major timber management problems in Colorado. The problem is discussed more fully in this report under forest development and management.

There are three true firs in Colorado — subalpine fir, corkbark fir, and white fir. Subalpine fir and corkbark fir are the principal associates of Engelmann spruce and are widely distributed at higher elevations. These two firs are relatively small, and in Colorado their total sawtimber volume is about one-fifth that of Engelmann spruce. In Colorado white fir grows only in the southern part of the State, usually in mixture with Douglas-fir. Most of the white fir volume is on the San Juan National Forest where the tree reaches large size. More than two-fifths of the sawtimber volume is in trees 21 inches or larger in diameter.

In 1962 saw log output for the two species of fir amounted to 6.4 million board feet, or about 3.5 percent of the total saw log production in the State.

Blue spruce is probably the most widely known of Colorado's trees, as its form and color give it unusual beauty. It is not important for lumber. Blue spruce trees grow singly or in small groups in all forest types along stream courses, canyon bottoms, and other moist sites.

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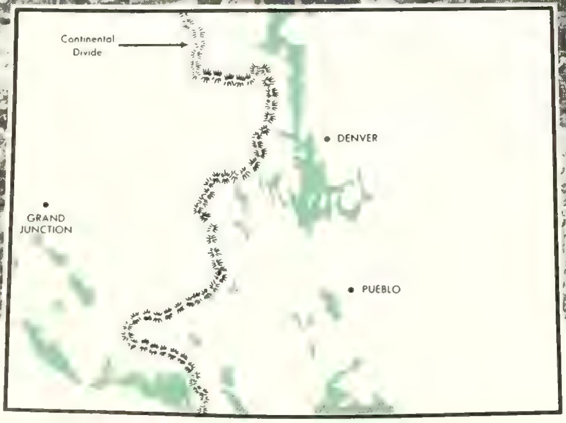
[7] *Unless otherwise specified, a log length of 16 feet is used throughout this report.*

Virgin stand of ponderosa in the Piedra River Canyon, San Juan National Forest. The stand is small sawtimber, and trees range from 14 to 28 inches in diameter. Average height is 115 feet and average age 140 years. There are about 110 trees per acre.



The Ponderosa Pine Forest

	Thousand acres
Sawtimber	1,504
Poletimber	553
Seedling-sapling	5
Nonstocked	285
Total	2,347

Ponderosa pine was mainstay of early lumber use

Since the Colorado Gold Rush in 1859, ponderosa pine has had a high and sustained rate of use. Many ponderosa pine stands east of the Continental Divide were clear cut during the Gold Rush and other early mining periods, and used for lumber, mine timbers, and fuelwood.

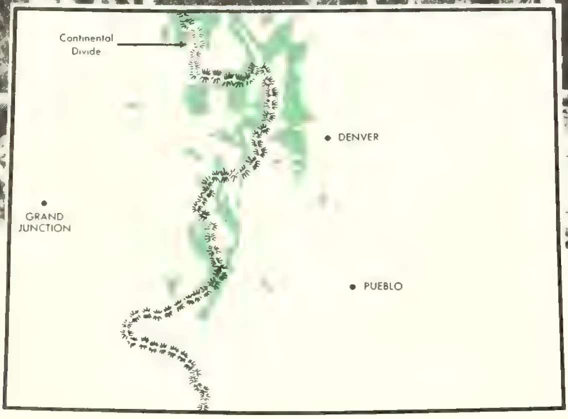
Of the sawtimber cut in Colorado within the last 90 years, about 2.6 billion board feet or 40 percent has been ponderosa pine. Until 1944 when it finally gave way to spruce, ponderosa pine was consistently the leading species in the volume of sawtimber cut. Accessibility, large tree size, and good lumber qualities have resulted in heavy cutting in the ponderosa pine type. Because most of the ponderosa pine acreage has been cut over at least once, present stands are low in volume. The present volume of ponderosa pine sawtimber is 3.8 billion board feet, or about 7 percent of all sawtimber in Colorado. In 1962 the saw log cut of this species was about 19.5 million board feet, or about 10 percent of the total saw log output for the State.

The ponderosa pine type occupies 19 percent of the commercial forest area and covers much of the forest below 8,000 feet elevation. It also grows on ridgetops, south-facing slopes, and other drier sites up to about 9,500 feet. Largest areas of the type are on the Uncompahgre Plateau and adjacent tablelands, lower southern extensions of the San Juan Mountains, and along the Front Range at lower elevations.

As shown in the tabulation on page 14, an unusually large proportion of the ponderosa pine area is nonstocked and there are extremely few seedling-sapling stands. These conditions reflect the dry site conditions of ponderosa pine lands and the invasion of past cutover and burned areas by Gambel oak. Regeneration of the extensive areas under these conditions represents a big and costly job. Costs per acre are high due to the necessity for site preparation, planting, and in some cases replanting. A serious economic problem is presented by high costs which limit accomplishment and make many sites economically marginal. A technical problem remains in the need for developing more economical reforestation methods.

Within its elevational range, ponderosa pine is widely distributed in Colorado. Consequently, there is great variation in tree quality and size because of differences in climate and other site factors. Heavy cutting in the past has reduced tree size and quality in many areas. The percentage of logs in grades 1 and 2 (clear or almost clear logs that turn out a high percentage of knot-free lumber) varies among principal ponderosa pine areas from 6 percent or less on the Roosevelt, Pike, and San Isabel National Forests on the eastern slope, to as high as 26 percent in the San Juan National Forest in southwestern Colorado. Less than 14 percent of the ponderosa pine sawtimber volume is in large sawtimber trees (21 inches d.b.h. or larger) on the Pike and Roosevelt National Forests, but on the San Juan such trees make up about 56 percent of sawtimber volume.

Ponderosa pine has been cut largely for lumber but could be used for poles and pulpwood. The large volumes of low-grade ponderosa pine material that are suitable for pulpwood add to the opportunities for plants or processes to supplement sawmill operations.



The Lodgepole Pine Forest

	Thousand acres
Sawtimber	714
Poletimber	1,252
Seedling-sapling	95
Nonstocked	7
Total	2,068

This sawtimber stand on the Routt National Forest in Jackson County is representative of aged, virgin lodgepole pine forest on better-than-average sites in Colorado. Sawtimber trees in this stand range up to 18 inches in d.b.h., average about 80 feet in height, and are about 225 years old.

Lodgepole pine is northern Colorado's utility species and problem tree

Lodgepole line is a versatile tree. It has been used for a longer time and has provided a greater variety of products than any other species in Colorado. Indians used the slim poles in their tepees and lodges. Pioneers built homesteads and fences and shored their mines with lodgepole pine timbers. Lodgepole pine has figured prominently in Colorado's commercial timber industry ever since the days of the tie hack. Colorado lodgepole pine ties hewn by those famed "timberbeasts" contributed to the development of the railroads and the West. Ties are now squared in a sawmill and the red man's lodge pole has evolved to the modern machined house log, but all the early commercial uses continue and are growing.

Growth of lodgepole pine is reduced by heavy dwarfmistletoe infections. Stagnation from overcrowding is also a problem. This growth reduction is the principal reason many thousands of acres bear lodgepole pine timber no larger than pole size even though they are mature in years — in some cases 150 or more years old.

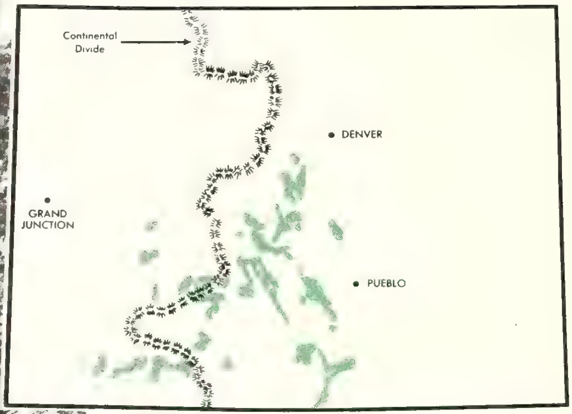
In addition to the 1.3 million acres of lodgepole pine poletimber stands, there are many pole-size trees in sawtimber stands. In fact, poletimber trees make up about one-half the cubic volume in lodgepole pine sawtimber stands. Many of these trees are left unused in saw log operations because of lack of market. And because of a lack of growth potential, these pole-size trees are not considered desirable for future harvesting. Present National Forest practice is to destroy these residual trees. Although much sound volume is lost, there is an advantage in converting to a new even-aged stand free of mistletoe.

Lodgepole pine has many characteristics that can be at once bane and blessing to foresters and industry. For example, lodgepole pine regenerates well, but many stands soon become overstocked and stagnated. The dense even-aged stands produce straight clear boles, but at a great sacrifice in growth. Open stands grow rapidly, but with limbs to the ground. Slow growth limits tree size and treatability, but contributes to even texture. Logs have clear surfaces and small, tight knots — but with little depth in clear wood. There are big volumes suitable for pulp — but so far there is practically no market. Clear cutting is the best management technique and is easy to carry out — but leaves large residual unmerchantable volumes to be removed. The small logs and nature of the terrain permit the use of light logging equipment — but output is low and costs per unit are consequently high.

And in still other ways good features are inseparably linked with bad. Despite long, largely clear stems suitable for poles, spiral grain is frequent and generally not identifiable in the tree. The lumber with small knots makes good paneling, but the knots lessen the strength. Lumber quality is comparable to ponderosa pine — but boards are narrow and hard to sell, and the high proportion of juvenile wood makes shrinkage uneven. Lodgepole pine supports a sawmill industry — but mills are frequently small, economically marginal, and handicapped by management and operating problems.

But despite its limitations, Colorado's lodgepole pine is a valuable timber resource with much potential for future production and use (*19*). Although lodgepole pine makes up only slightly more than one-tenth of Colorado's total sawtimber volume, it provides about one-third of the State's lumber production. Colorado is a leading State in lodgepole pine lumber production. Besides furnishing logs for sawmills, lodgepole is the principal species for a timber treating industry in northern Colorado. Its use for dimension lumber is also growing.

Lodgepole pine grows at intermediate elevations and to a large extent on relatively accessible areas — an advantage for all uses. In addition to present uses, it has qualities suitable for pulpwood, plywood, and particle board. However, before these uses can become significant, markets must develop and problems must be solved in the fields of harvesting, mistletoe infection, and management of young stands for sustained growth.



The Douglas-fir Forest

	Thousand acres
Sawtimber	**1,046**
Poletimber	**397**
Seedling-sapling	**4**
Nonstocked	**4**
Total	**1,451**

Douglas-fir sawtimber on the San Juan National Forest. The tall tree shown in the center of the photo represents nearly the maximum in development of Douglas-fir in Colorado. It is 120 feet in height, 33 inches in diameter, contains five logs, and is about 225 years old.

Douglas-fir is of limited use for timber but has other important values

As a timber species, Colorado Douglas-fir has a number of shortcomings. The better quality trees were removed in early-day logging. Furthermore, wood from Colorado Douglas-fir is slightly lower in strength and specific gravity than wood from the coastal and northern Mountain States. Because of the prevalence of knots and shake, Colorado Douglas-fir yields a much lower proportion of top-grade lumber than trees of this species do in other parts of its range. In most locations in Colorado, particularly in the north and along the Front Range, Douglas-fir trees grow on relatively unfavorable sites, frequently on rocky, shallow-soiled slopes. As a consequence trees in these areas are usually short and limby.

Most Douglas-fir stands are quite important for values other than timber. At lower elevations on dry sites older stands of Douglas-fir are fairly open and have a substantial understory of forage for wildlife and domestic livestock. Along with more extensive areas of ponderosa pine, Douglas-fir stands are a principal winter range for mule deer, elk, and bighorn sheep, particularly along the Front Range.[8] Large areas of Douglas-fir, accessible to the centers of population, are heavily used for recreation. And in many areas, Douglas-fir stands are extremely important for watershed protection.

The Douglas-fir type covers about 12 percent of Colorado's commercial forest area and lies largely between 8,000 and 10,000 feet in elevation. The main concentration of the type is in the southern half of the State, where the species reaches its best growth on the San Juan National Forest. The favorable size of trees in this area is indicated by the photo on page 18, and the cover photo. The latter shows a stand about 120 years old with many trees more than 110 feet high and 18 inches in diameter.

Colorado's 5.4 billion board feet of Douglas-fir sawtimber represents about 10 percent of all sawtimber in the State. Although less than 4 percent of the State's saw-log output is Douglas-fir, the species is of considerable local importance for production of structural lumber, particularly in counties along the Continental Divide in the southern half of the State. Douglas-fir is Colorado's strongest commercial wood. When slight adjustments are made in the size and spacing called for in specifications, Colorado's Douglas-fir lumber is suitable for the same construction uses as west coast Douglas-fir, in grades and sizes available (5).

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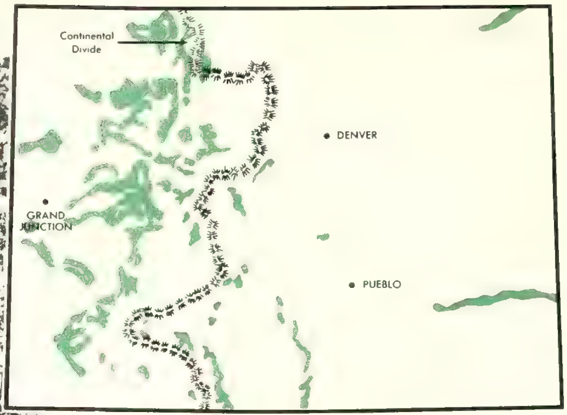
[8] *Smith, Dwight R. Forest game and fish habitat research in the central Rocky Mountains. A project analysis and working plan. Rocky Mountain Forest & Range Expt. Sta., unpubl. 1962.*



The Aspen Forest

	Thousand acres
Sawtimber	201
Poletimber	2,226
Seedling-sapling	365
Nonstocked	2
Total	2,794

These large sawtimber aspen trees are representative of the size attained by many aspen trees in Colorado. They range from 21 to 24 inches d.b.h., average 90 feet in height, are about 110 years of age, and contain three to four logs per tree.

Aspen grows exceptionally well in Colorado

Aspen, the most widely distributed tree in North America, is at its best in Colorado. About 23 percent of the commercial forest or 2.8 million acres is aspen type. This type is the second largest in the State. Colorado's 3.5 billion board feet of aspen sawtimber, and 2.4 billion cubic feet in sound live trees, is more than is found in any other State.

Aspen varies widely in size, quality, and vigor. In many stands, particularly in the noncommercial forest, trees are short, poorly developed, badly cankered, and infected with heart rot. Elsewhere trees grow to large size and yield big volumes per acre. The best aspen are in the southwestern part of the State where trees reach 24 inches in diameter and 100 feet in height.

Although many aspen stands do not appear sufficiently productive to justify timber management investments, they are valuable for other uses. Yellow, orange, and red foliage of aspen in the fall provides one of the State's scenic attractions. Aspen stands frequently have root sprouts and other understory vegetation that are excellent forage for big game and livestock. Colorado aspen stands on the western slope with a forb understory have been characterized as probably the finest summer lamb and game range in the central Rocky Mountain area (*14*). Aspen, like other hardwoods, is valuable for its soil-building capability.

Most aspen stands in Colorado originated following fires, many within the last 100 years. Many stands came in on poor sites. This factor and the short-lived nature of the species are important reasons why only about 7 percent of the aspen type is in sawtimber stands. However, at present aspen sawtimber trees have an average volume of 120 board feet per acre, and in this respect rank well above ponderosa pine and somewhat below Douglas-fir.

Aspen, long considered a weed tree, has many desirable characteristics (*13*). It is very satisfactory for many industrial uses because it is light, uniform in texture, soft but tough, straight-grained, easy to work, and is tasteless and odorless. It also is quite shock resistant and low in shrinkage. The principal uses in Colorado are for match-splint veneer, core stock for doors, excelsior, lumber, and dimension stock. Actual output of aspen saw logs in 1962, however, was a little less than 1 million board feet.

Limber and bristlecone pine and cottonwood are minor types

Desirable watershed and scenic values pretty well sum up the importance of the 139,000 acres of limber and bristlecone pine types. Trees of these two species, which are in the general white pine group, are small, limby, and with poor form for timber use. The type always occurs on poor sites — thin-soiled ridgetops and other dry and exposed rocky locations. Practically all of the 472 million board feet in these species is limber pine.

Cottonwood is one of the best known trees in the State, but its inventory volume and timber cut are insignificant. On the plains of eastern Colorado it has esthetic value, and is important as a shade tree and a source of farm lumber. Its major commercial use is for pallets.

Estimates of 83,000 acres of cottonwood type and 288 million board feet of sawtimber in Colorado are actually low because trees frequently occur singly or in small clumps and narrow stringers that are not classed as forest land and not included in the inventory.

Both eastern and western species of cottonwood are native to Colorado. The type is limited to stream courses and flood plains. Eastern or plains cottonwood is generally limited to less than 6,000 feet in altitude. Black cottonwood, the western species, grows to commercial size up to 9,000 feet in some areas.

More than nine-tenths of the cottonwood type is located outside National Forest boundaries and most of it is in private ownership.

FOREST OWNERSHIP

The public owns a preponderance of the commercial forest area and timber volume

The present ownership pattern is largely the result of the establishment of National Forests between 1891 and 1908. With preservation of watershed and timber values as primary objectives, National Forest boundaries were established along lower limits of the predominantly mountainous forest area. Since establishment of the White River National Forest in 1891, about 8.4 million acres or about two-thirds of the commercial forest area has been brought under administration of 12 National Forests lying wholly or partly in Colorado. These lands support about 80 percent of the State's commercial timber volume. National Forest ownership of sawtimber volume varies by species from about 58 percent for ponderosa pine to 90 percent for fir and spruce.

Other public ownership totals about three-quarters of a million acres, a little more than one-half of which is administered by the Bureau of Land Management[9] and consists of isolated areas or lower extensions of the commercial forest. Indian lands are within the Ute Reservation in southern Colorado. State forest lands are mainly in the Colorado State Forest on the western slope of the Medicine Bow Range in Jackson County.

Other variations in the general pattern include: the Federal-private checkerboard pattern of ownership in northern Larimer County which resulted from original railroad grants; a scattering of privately owned tracts obtained by mineral patent on the National Forests; and the large private ownerships in southern Colorado which have origin in Spanish grants. Distribution of ownership by principal classes is as follows:

	Commercial	*Noncommercial*	*Total*
	Thousand acres		
National Forest	8,384	2,224	10,608
Other Federal	523	3,582	4,105
State, county, and municipal	235	338	573
Private	3,133	4,164	7,297
Total	12,275	10,308	22,583

More than one-third of all forest lands are non-Federal and most of these are private

Nearly 8 million acres or about 35 percent of all forest lands in Colorado are in non-Federal holdings. Private ownerships comprise about 93 percent of the non-Federal holdings and consist of 3.1 million acres of commercial forest and 4.2 million acres of noncommercial — largely pinyon-juniper and chaparral.

The ratio of public to private ownership of the commercial forest area is about 3 to 1. However, the ratio varies substantially when timber types are considered. The fir-spruce type, which occurs at high elevations and is relatively inaccessible, is almost 80 percent public ownership. On the other hand, ponderosa pine lands, which are at the lower ranges of the commercial forest and are more accessible, are almost 50 percent in private ownership, principally in farms and ranches. Heavier timber harvesting, together with clearing to improve yields of livestock forage have reduced stocking of ponderosa pine on farms and ranch lands. On these lands about 24 percent of the type is nonstocked as compared with 3 percent on National Forests.

Survey statistics on present acreages, volumes, and stocking are an inadequate basis

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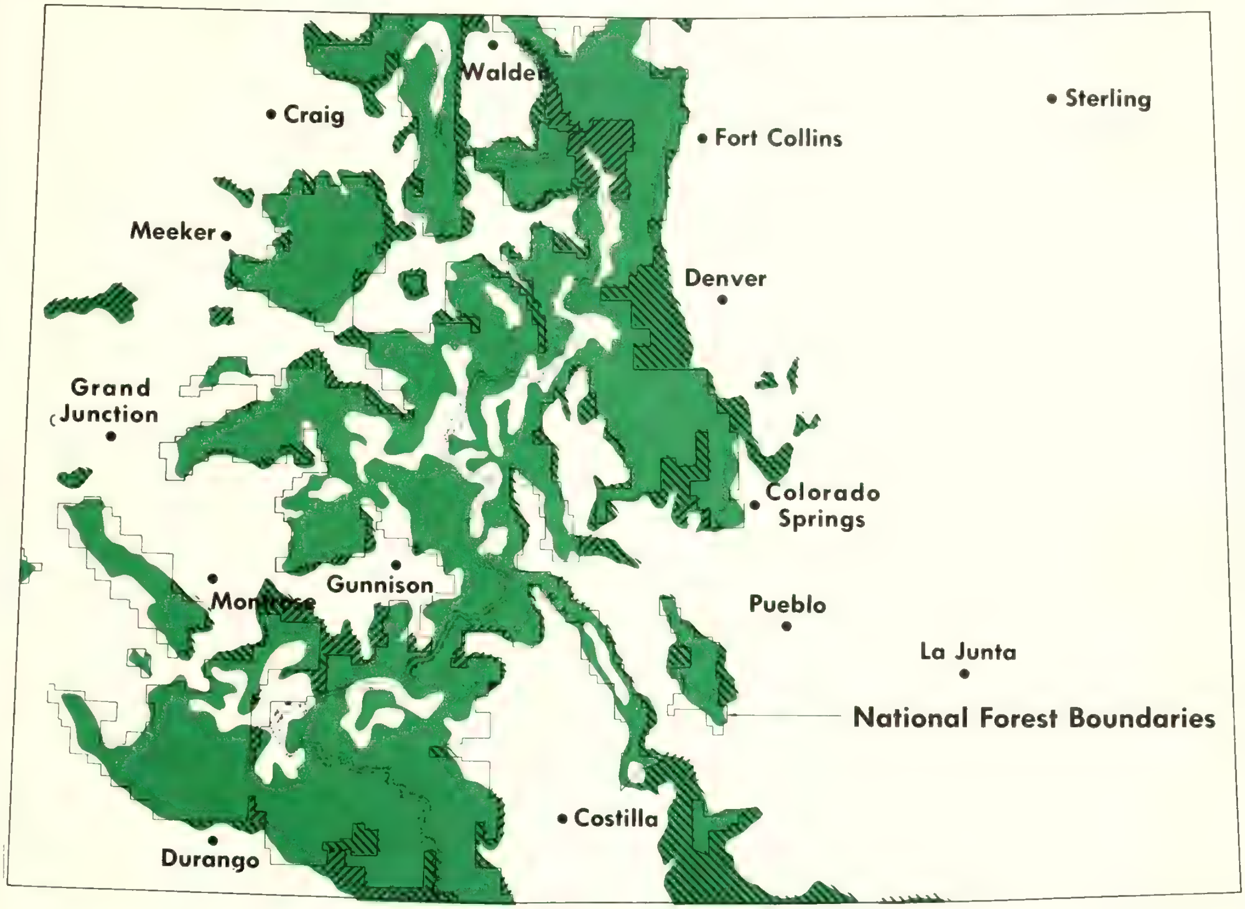
[9] *The Bureau of Land Management, which has a policy of sustained yield management of commercial forest lands similar to that of the Forest Service, is presently conducting an intensified forest survey of their lands. This survey will soon provide much more detailed data than are now available on timber inventory and management needs.*



PRODUCTIVE FOREST AREA IN COLORADO BY PREDOMINATING OWNERSHIP, 1959

In the map above almost all the forest area delineated within the National Forest boundaries is National Forest land. Outside the National Forests, Private, and Other Public ownerships are in general much interspersed. Exceptions are large blocks of State and Indian lands, and Spanish grant lands. Private and Other Public areas are separated on the map on the basis of predominance (more than 50 percent) of ownership.

In addition to the productive forest area shown above there are 9.8 million acres of unproductive forest. These lands are all classed as noncommercial and comprise 95 percent of the noncommercial forest shown by the map on page 1. Fifty-eight percent of the unproductive lands are in public ownership, the remainder are largely farm and ranch lands.

for comparing the relative economic importance of private and public holdings. For example, although private lands comprise about 26 percent of the commercial forest area and have 14 percent of the sawtimber volume in the State, they provided only 8 percent of the sawtimber cut in 1962.

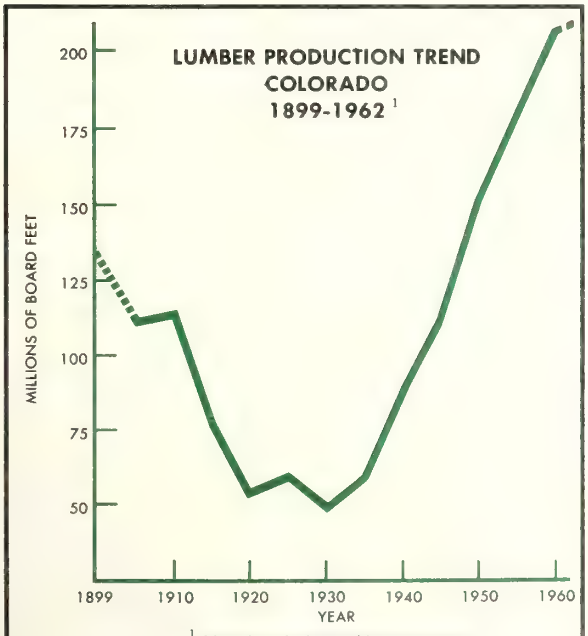
On the other hand, private lands have certain potential advantages. Because they generally have younger, more vigorous trees, growth rates are higher than on most public lands. Furthermore, private lands are usually more accessible for protection, planting, cultural treatment, and harvesting. However, these advantages will not result in better yields unless management improves. At present most private owners have a secondary or minor interest in timber production, and for the most part, have little knowledge of sound timber management. The Colorado State Forest Service is active in developing the potentials of private holdings, and as one of its projects is now compiling intensive county-by-county inventories of non-Federal forest lands. In some areas, such as Larimer County, non-Federal ownerships are a significant secondary source of supply (*2*).

Non-Federal lands are of great importance for forest uses other than timber. Pinyon-juniper and chaparral types and some of the commercial forest lands provide livestock forage and serve as winter game ranges. Recreation use is high and will undoubtedly increase rapidly. Most dude ranches, hunting and fishing lodges, and other private recreation facilities are located on private lands. And many of these lands will also be in demand for summer homesites or other residential use.

This stand in Archuleta County is characteristic of much of Colorado's privately owned ponderosa pine area. It is vigorous second growth but because trees are not closely spaced they will be too limby to produce high quality saw logs. Poor stocking also encourages invasion by oak brush.

DEVELOPMENT AND MANAGEMENT OF THE FOREST RESOURCE

From the standpoint of timber use and management — the principal concern of this report — the most urgent and complex problems relate to Colorado's 12 million acres of commercial forest. Here are the most rapidly developing water, recreation, and forage uses. All of these are affected by and have an effect on timber use. The situation in the noncommercial forest is generally less urgent and management is less complicated. On these lands timber use is negligible, there is less competition among uses, and the forest itself is undergoing less rapid change. Problems in the noncommercial forest — how much and what area to reserve and protect for recreation, and how to improve forage production and game habitat on pinyon-juniper and chaparral lands — have little bearing on development of timber use. For these reasons the remainder of this report discusses mainly opportunities and problems on commercial forests.



[1] Plotted on the basis of 5 year averages e.g. averages for years 1913-1917 plotted on 1915

Timber use is increasing but economic returns are much too low

Since 1900 timber use in Colorado has had many ups and downs. This is reflected in a general way by figures on lumber, which has been the major product over the years and accounted for about 87 percent of the wood that went into timber products in 1962. As shown in the chart on this page, the decline between 1899 and 1935 was followed by an increase that about quadrupled production by 1962. Output for 1962 is estimated at 208 million board feet (lumber tally) (*17*). Less information is available on the trend in other products, but there are no indications of any upward trend greater than that of lumber.

In 1962 Colorado had an estimated 170 active sawmills.[10] Distribution of active mills on the basis of production class is as follows:

Production class[1] (Thousand board feet)	*Number of mills*
10,000 or more	5
5,000 to 9,999	3
1,000 to 4,999	37
500 to 999	20
200 to 499	19
50 to 199	49
Less than 50	37
Total	170

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[10] *Estimate based on a survey conducted in 1963 by the Intermountain and Rocky Mountain Forest & Range Experiment Stations for the purpose of estimating the output of roundwood products in 1962.*

[1] *It is usual practice to base mill production class on annual lumber output, but in this tabulation it is based on volume of log receipts in 1962.*

Although the number of active sawmills decreased from 274 in 1957 to 170 in 1962, lumber production increased from 188 to 208 million board feet. A comparison of number of active mills by size class for the 2 years shows that dropouts were largely small mills. In 1957 there were 47 mills, or 17 percent of all mills in the State, with a production capacity of 1 million board feet or more a year. In 1962, there were still 45 mills of this size and they constituted 26 percent of the State's mills. On the basis of saw log receipts these 45 mills produced 85 percent of the State's lumber in 1962. In 1957, the 47 mills of this size produced 72 percent of the lumber. Big mills got bigger (and somewhat fewer); small mills got fewer. In 1957, average production per sawmill in Colorado was 0.686 million board feet; in 1962 it was 1,224 million.

The map on this page shows the geographic distribution of sawmills and indicates the counties that individually produced at least 10 million board feet of saw logs in 1962.

During the 1957-62 period, wood cut into saw logs for the lumber industry increased from 78 to 87 percent of the cut for all primary products. The latter figure is about the same as for the Mountain States as a whole, and therefore Colorado is not an exception in relying on lumber as the bulwark of the timber industry. A very minor amount of pulpwood was cut in Colorado in 1962, and this was shipped out of the State. An increase in pulpwood cut would be highly desirable. There would be still further economic gain if pulpwood were converted into paper or other secondary products within Colorado.

Several methods of measurement show that, in relation to inventory, Colorado's timber use and economic returns from timber are among the lowest in the Mountain States. In 1962 Colorado cut only 0.22 percent of its inventory of sound live trees and cut only 2.1 million of its 3,329 million cubic feet of dead but usable timber. The following tabulation reveals that Colorado and Utah are the lowest of the eight Mountain States in annual percentage of cut from inventory of sound live trees.

	Percent of inventory cut, 1962
Colorado	**0.22**
Utah	**.22**
Wyoming	**.29**
Nevada	**.36**
New Mexico	**.53**
Montana	**.79**
Idaho	**.93**
Arizona	**1.06**
Mountain States	**0.66**

And as shown in the table on page 27, Colorado also compares unfavorably with other Mountain States in economic returns from timber harvesting.

COLORADO SAWMILLS AND PRINCIPAL SAW LOG PRODUCING COUNTIES — 1962

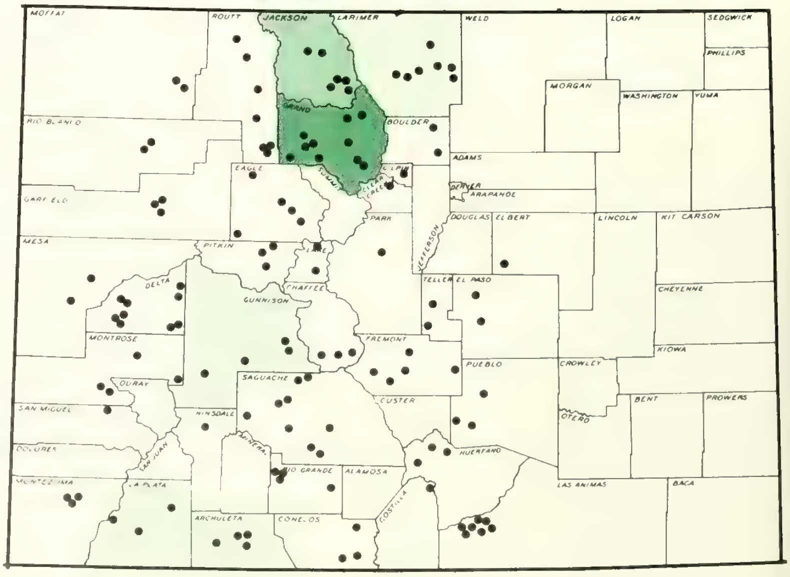
- Sawmill known to have operated in 1962[1]

Counties that each produced more than 10 million board feet of saw logs in 1962.

▢ 10-20 million

🟩 20-30 million

🟩 More than 30 million



[1] *In addition to the 126 mills shown on the map there were an estimated 44 active mills that did not furnish a report in the 1962 timber products survey.*

Estimated Employment in Timber Harvesting[1] and Estimated Value of Shipments from Primary Manufacturing Industries[2] in Relation to Inventory,[3] Mountain States, 1958

State	*Employees*	*Value of shipments*
	Per billion cu. ft. of inventory	
	Number	*M dollars*
Colorado	**46**	**1,722**
Arizona	**168**	**4,835**
New Mexico	**128**	**3,476**
Idaho	**156**	**5,554**
Montana	**102**	**1,989**
Wyoming, Utah, Nevada	**54**	**1,263**
All Mountain States	**108**	**3,152**

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[1] *All employment involved in harvesting and transporting timber and related products from forest to local points of delivery.*

[2] *Includes sawmills and planing mills, veneer and plywood plants, paper and paperboard mills, and other industries manufacturing such minor products as shingles, excelsior, and charcoal.*

[3] *Volume of all sound live trees 5 inches and larger in diameter.*

Source: Dwight Hair. The economic importance of timber in the United States. U.S. Forest Serv. Misc. Pub. 941. 1963. Wash., D.C.

A bigger cut can improve management in Colorado's old-growth forests

Sluggish development of Colorado's timber resource has tended to perpetuate the overmature condition of much of the forest. Survey data indicate that for practically all forest types the preponderance of sawtimber volume is in overage, slow-growing trees. Most of the spruce-fir and lodgepole pine sawtimber stands are beyond rotation age. At least 25 percent of the lodgepole pine poletimber stands are more than 100 years old, and most of these are stagnated. Substantial proportions of other types are also overmature.

These old-growth stands are the major timber management problem in Colorado. Protection is of special concern because of the catastrophic changes that may result from insects and blowdowns. The potential in devastation by forest insects in Colorado has been amply demonstrated. Between 1940 and 1951, the Engelmann spruce beetle killed an estimated 5 billion board feet of Engelmann spruce in Colorado following blowdowns that provided large amounts of host material for insects (*20*).[11] This volume is equal to almost 10 percent of the present sawtimber inventory of all species. In aged stands such as these the constant presence of dying trees and blowdowns is so favorable to the spruce beetle

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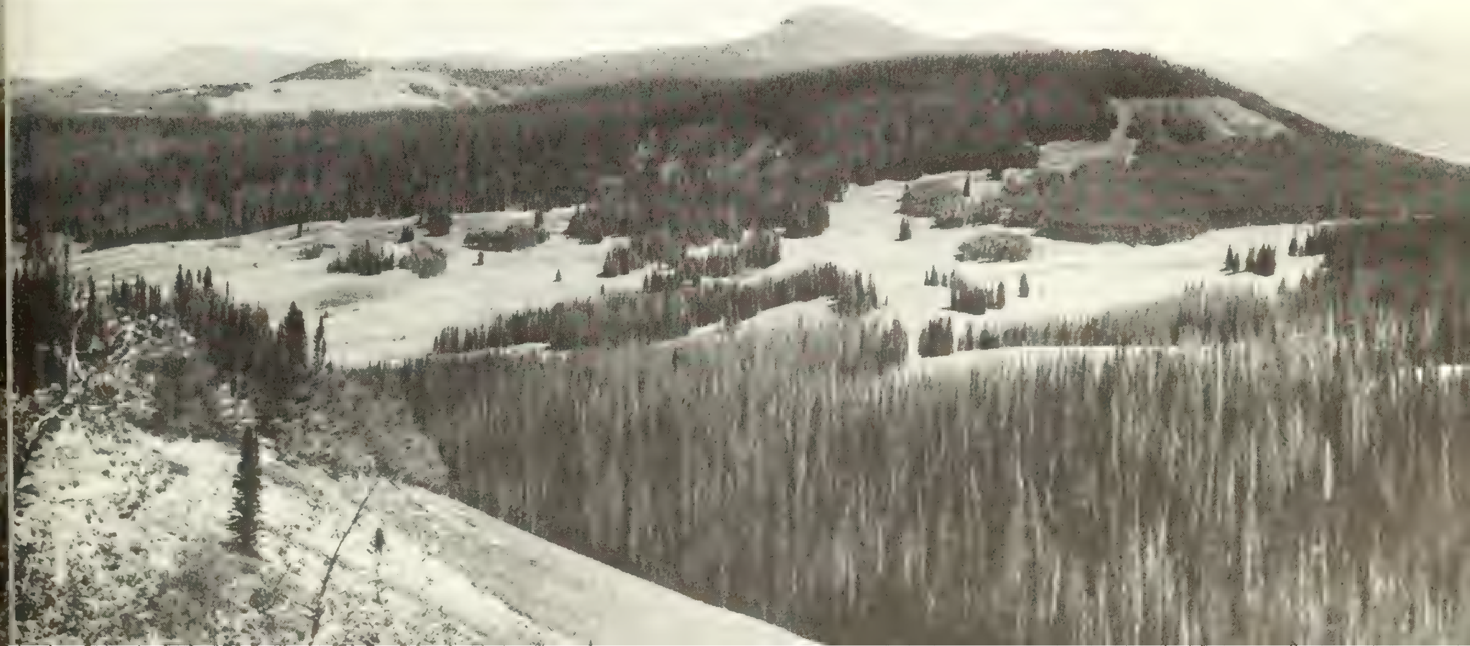
[11] *This loss is not revealed by the mortality tables in the appendix because it occurred before the period of the survey.*

Extensive area of beetle-killed Engelmann spruce on the Routt National Forest.



that costly surveillance and treatments are required to prevent epidemic losses.

Other insects are active throughout the forests: The Black Hills beetle is causing heavy losses along the Front Range and in other ponderosa pine forests on the eastern slope; spruce budworm attacks have defoliated Douglas-fir and white fir on 600,000 acres in the State in the last 6 years; the Douglas-fir beetle causes high local mortality.

The effects of disease, diffuse and less spectacular than insect damage, nevertheless are major factors in timber cutting needs. Dwarfmistletoe is not only very damaging to lodgepole pine as already described, but is very prevalent in ponderosa pine stands. Wood rotting fungi, rusts, and other diseases are also widespread.

Combined effects of insects and disease result in an annual sawtimber mortality of 453 million board feet, or far more than the annual cut of 196 million board feet. However, not all of this mortality is in species that are now of economic importance for timber; 188 million board feet is in subalpine fir, a species which accounted for only about 3 percent of the sawtimber cut in 1962.

Insects and diseases also have a big effect in retarding tree growth. The growth loss from these agencies is not known, but it probably greatly exceeds losses from mortality.

The decadent condition of Colorado's old growth forest is indicated by the fact that one out of five trees of sawtimber size is either cull or dead (but sound). These trees, not presently salable, handicap harvesting and postharvesting treatment and furthermore are esthetically undesirable.

These characteristics of the old growth — big protection costs, constant high mortality and growth losses, and (especially) the high risk of catastrophic losses of spruce — point to the need for a much bigger cut. Risk of major losses through insect outbreaks is extremely critical because of the large volumes of timber involved. However, other problems in resource use and management created by sudden, uncontrolled changes over extensive fir-spruce forests are even more significant. A faster rate of harvest would not only utilize much timber that would otherwise be lost, but since harvesting is one of the means of preventing outbreaks of the Engelmann spruce

Small mill sawing trap logs from a project for controlling Engelmann spruce beetle on the San Juan National Forest. The location of this temporary mill — at a high elevation and about 50 miles from the nearest paved road — illustrates difficult access problems and resulting high costs encountered in protecting much of the forest area.

beetle, it would be of even greater importance as a management measure in controlling changes in Engelmann spruce stands. Protection, silviculture, and the anticipated future timber demands would benefit from the orderly conversion of the old growth to young vigorous stands.

On the other hand, it is necessary to consider that too rapid a cut will result in a scarcity of mature stands at some later time. Also, regeneration is a major problem in some stands and large-scale harvesting with poor regeneration would reduce productivity for a long time to come. Such actions would defeat objectives of sustained yield and industrial stability.

Difficult problems of regeneration are restrictive to harvesting

Difficulties in regenerating ponderosa pine and Engelmann spruce have been mentioned earlier. Of the two species, Engelmann spruce is technically more difficult to regenerate and the costs are greater; its regeneration cannot be considered apart from interrelated problems of insect protection and harvesting.

The two methods of preventing and controlling bark beetle buildups in Colorado — harvesting and use of insecticides — have advantages and disadvantages from the standpoint of regeneration. Harvesting, supplemented by trap tree measures, and the burning of all residual host material, is now used almost exclusively as the control method in overmature spruce stands. It is an especially attractive method because it provides some returns to offset road and artificial regeneration costs. However, as a control measure, harvesting has serious limitations under some conditions. When harvesting is begun in an aged spruce stand, balances are upset, and to use a current expression, "The forest tends to unravel." Blowdowns occur along cutting boundaries and require subsequent treatment for bark beetle control. The most serious problem resulting from harvesting is frequently the failure to get natural regeneration in the cut areas. The usual beetle-control practice of burning residual material leaves the cut areas without enough shade and moisture for the establishment and development of spruce seedlings. Planting and replanting is often necessary and may cost more than the value of timber harvested. The success of Engelmann spruce regeneration, planted and natural, is estimated at not more than 30 percent; it may actually be considerably less, particularly where cutting is in larger blocks.

When harvesting is not feasible or desirable, insecticides can be used to control the bark beetle population. This control method does not destroy existing reproduction or deteriorate shade and moisture conditions favorable to the establishment of seedlings.

The variations in productivity, age, vigor, and size among stands are important factors complicating the problems of harvesting, protecting, and regenerating spruce stands. Some stands have substantial advance reproduction, while others do not. Stands differ in susceptibility to blowdown. These variations suggest two things: first, that there is probably no single solution to the problems and that treatment must vary according to local conditions; and second, that there is a real need for more detailed stand data, more silvicultural research, and the development of improved management techniques.

In forest types other than Engelmann spruce, it appears at the present time that there is less risk of catastrophic losses and, therefore, more opportunity to spread out the cut and avoid future fluctuations in yield. A prolongation of cut for other species would have the advantage of partly offsetting any future temporary declines in the yield of spruce.

It is difficult to estimate volumes available for cutting in future years because of problems and inadequacies of knowledge described above. Other factors complicating management, such as the overriding importance of uses other than timber in some areas, and operability limitations due to steep slopes and soil instability, will also tend to limit timber use. Although improved knowledge in multiple use management, and better technology, logging equipment, and markets can alleviate the latter problems, the extent of these developments is indeterminate.

Timber Volume on Commercial Forest Land by Class of Timber and by Species

Class of timber	All species	Ponderosa pine	Lodgepole pine	Engelmann spruce	Other softwoods	Aspen and other hardwoods
Sawtimber trees:	Million cubic feet					
Saw log portion	8,807	740	1,041	4,126	2,368	532
Upper stem portion	923	69	55	410	223	166
Total	9,730	809	1,096	4,536	2,591	698
Poletimber trees	7,607	208	2,190	1,665	1,802	1,742
Sound wood in cull and salvable dead trees	4,777	77	527	1,859	1,143	1,171
Total, all timber	22,114	1,094	3,813	8,060	5,536	3,611

The table on this page shows the present volume of all species in terms of broad product groups: (1) saw logs and veneer logs, and (2) small diameter and other material suitable only for products in round or converted form, such as poles and pulpwood.

How much of the 8.8 billion cubic feet of saw log volume should be budgeted for annual cut within the next few years can vary greatly, depending on management decisions regarding the many complex factors described above. The preponderance of saw log volume in Engelmann spruce and the species associated with it (40 percent of the volume in *Other softwoods* is subalpine fir), indicates the big influence that decisions on managing and harvesting the old-growth stands of fir-spruce will have in the allowable cut. It would be desirable to spread the old-growth harvest over a rotation (about 140 years) in order to obtain optimum conditions of stocking, age, and species distribution in the shortest possible period. It is highly unlikely, however, that many of the present old stands with high mortality will last that long. Even in the absence of massive losses as a result of insect outbreaks, large areas of the old, even-aged, spruce forest can be expected to go out long before the end of the next rotation. Existing spruce beetle control methods are limited in capability to forestalling outbreaks. In fact, additional blowdowns as a result of roadbuilding and harvesting could result in insect buildups and accelerate the rate of loss of old growth. It is apparent, therefore, that many complicated decisions must be made in managing and utilizing old-growth Engelmann spruce, in the process of convertin to young, more productive forests and, at the same time, managing for other uses.

A thorough analysis of the many factors to be considered in estimating the allowable sawtimber cut is beyond the limited scope of this report. However, it does appear that the sawtimber inventory will permit a big increase in cut beyond the present level of about 30 million cubic feet, or 196 million board feet a year. The increase probably could be about triple the present cut.

In addition to the live sawtimber there is a big volume in poletimber trees, cull trees, and salvable dead trees available for harvest. In 1962 the cut of such trees amounted to only about 9.5 million cubic feet. A sustained yield of at least seven times this amount is feasible. Probably about one-half of the 2.2 billion cubic feet of lodgepole pine poletimber is in stagnated poletimber stands or in poletimber trees in saw log stands. In lodgepole pine and fir-spruce stands most of the poletimber trees are destroyed during postlogging treatment; and this volume is also available for harvest.

National Forests with four-fifths of the wood volume in Colorado obviously have a major influence on the allowable cut for the State. Allowable cut on Colorado's National Forests has increased sustantially within the last 10 years and is now considerably higher than the actual cut of about 196 million board feet a year from all lands. Industry is not absorbing the available supply.

Questions of allowable cut and the need for cutting as a forest management measure are only of academic interest unless timber is marketable. An expanded cut can materialize only if and when timber can be logged and marketed profitably. This hinges on two related factors — demand for timber and access to it — discussed in the following sections.

Colorado needs a diversified and integrated timber industry

Colorado's timber industry is mainly a sawmill industry with little or no integrated processing. A number of explanations for lack of development have been offered. Instability,[12] intermittent operation, and inconsistent quality of manufacture have been cited as serious limitations to efficient production and increased output in the sawmill industry (*1*). Poor marketing practices and prejudice in Colorado against locally produced lumber have been found to be limitations to adequate use of Colorado's timber.[13]

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[12] *A suggested drawback to a program of accelerated harvesting is that operations with large capital investments may be reluctant to move in when abrupt reductions in supply can be foreseen. That this may not be true (at least of sawmills) is indicated by a sale made on the San Juan National Forest in 1962. The sale contract provided that the estimated 106 million board feet on the sale area is to be cut by late 1968. The purchaser, a local operator, is installing additional mill capacity to handle the sale. The three other bidders were west coast firms. Even in the case of a papermill, the amortization period in relation to the period for available adequate supply does not appear to be a limiting factor (8).*

[13] *Hughes, Jay M. Price and prejudice in the marketing of Colorado lumber. Master's thesis, Colorado State Univ. 171 pp. typewritten, 1958.*

Engelmann spruce and subalpine fir logging residues piled at a landing on the Roosevelt National Forest. This material, averaging about 7 inches in diameter at the large end, ranges up to 20 feet in length to a top diameter of 4 inches. A market for these woods residues would defray some of the logging costs chargeable to saw logs.

This small sawmill on the Colorado State Forest in Jackson County operates on small lodgepole pine and Engelmann spruce saw logs. It is representative of the numerous small mills in northern Colorado.

Figures in the following tabulation of output of primary products in 1962 show that the preponderance of cut is saw logs. These are used almost exclusively for lumber. Only about 13 percent of the cut is for other products.

	Thousand cubic feet
Saw logs	**31,563**
Poles	**482**
Mine timbers	**1,411**
Miscellaneous industrial wood	**1,946**
Posts	**329**
Fuelwood	**702**
All products	**36,433**

One important source of raw material for a more diversified and integrated industry is the big volume of sawmill residues — sawdust, slabs, edgings, and trim. Most of this material now has to be burned and at some cost. In many small sawmills these residues amount to as much as 50 percent of the saw log volume. Profitable conversion of coarse residues to chips for pulp making would strengthen the Colorado lumber industry and encourage a bigger timber cut.

The large amounts of low-grade and small-diameter material standing in the woods represent another very important source of supply for a wood-fiber industry. And until there is a market for much of this material, timber managers are greatly handicapped in putting timberlands in better shape to meet anticipated demands in the future.

Currently, sawmill residue is preferred to roundwood by the pulping industry as a source of raw material, and the availability of residues is likely to outweigh availability of roundwood in selection of a mill site. This situation could reduce the benefits which a pulpwood market would otherwise provide for improving management of timberlands. The amount of available sawmill residue, however, is hinged to lumber production and consequently supply is subject to some fluctuations. It is therefore unlikely that a pulp and papermill would rely on residue entirely. Anticipated benefits of a pulpwood market for timber management would therefore still apply.

A market for pulpwood offers the best possibilities for using mill residues as well as small dimension and low-grade roundwood. A study has just been completed that reports adequate supplies and facilities for a papermill on the Colorado River in western Colorado (*8*). Papermill operations may be feasible in other areas of the State. Development of substantial pulpwood export is a possibility, but is largely dependent on transportation costs and on economic conditions and development (i.e., those affecting pulpwood costs) outside the State. Encouraging signs are production of roundwood and chips in the Black Hills, production of pulpwood recently begun in west-central Wyoming, a small volume of dead spruce cut for pulpwood in Colorado in 1962, and initiation in early 1964 of shipments of chips from a sawmill in Kremmling. All pulpwood from these areas is being shipped to mills in Wisconsin.

Integrated plants with production and markets based on a variety of sizes and types of materials would have greater insurance against instability in supply. Even though supplies of sawtimber might decline, prospects of a continuing supply of small material suitable for fiber appear excellent. These prospects will become even better as forests are converted to young, fast-growing stands that will need thinning.

Development of a diversified and integrated industry will not occur without substantial research and promotional effort. Research is needed in the fields of marketing, product development, and in techniques and economics of harvesting, transportation, and product use. The most valuable contribution of research is likely to be in the area of reduction of costs in production and use. In view of the present economically marginal nature of many potential operations, substantial favorable shifts in cost relationships between Colorado and other timber producing areas may be basic to the development of a more adequate industry. As an example, important needs are to reduce production costs of lumber, and to develop cheaper methods of lumber assembly or installation in construction. Strengthening the lumber industry is particularly important because of the role of lumber production as the basis for needed secondary industries.

Road financing is not geared to problems of management and utilization

Inadequate road development is a major bottleneck to efficient forest management and timber utilization. Most of the operable old-growth stands lack access roads. In fact, success in handling the principal old-growth resource, Engelmann spruce, will stand or fall on whether those parts of the planned road system that lead to concentrations of overmature, high-risk stands are developed *in advance* of beetle outbreaks or dangerous beetle population buildups. These roads are necessary for insect control whether by harvesting or by use of chemicals. Because spruce beetle outbreaks cannot be precisely predicted, many of the access road into spruce timber should be established years in advance of actual need for harvesting or for chemical control measures.

The present system of financing does not permit construction of an adequate network of roads in advance of protection needs on National Forests, which contain almost all of the Engelmann spruce resource. On the National Forests, road development frequently has been tied to timber sale contracts or to meet current exigencies in insect control. As a result, it has not been possible to follow an orderly program of harvesting in priority of risk. Under these timber sale procedures, the size of a given sale must be sufficiently large to provide the operator a margin for profit and risk, cover estimated costs (including roads, and leave a residual for stumpage. But the location and limited area of some high risk stands precludes adequate returns unless other areas of low risk are included in the sale. And after an access road is constructed there is a tendency to harvest accessible stands, rather than higher risk stands not yet reached by road.

Although a greater proportion of new roads on National Forests is now being financed through direct appropriations than previously, the construction program is still far from adequate. Without a greatly accelerated program, timber management, protection, and utlization will continue to fall far short of realizing present values and attaining the potential in the future.

Other forest uses can benefit from increased timber use

Colorado's extensive areas of old-growth forest invite changes — devastating changes from natural causes or controlled beneficial changes from timber harvesting. Changes from blowdown and insects can be sudden, rapid, and extensive. Fire can effect major alterations in vegetative cover of both old and young growth. These changes, whether by natural causes or by logging, significantly affect all forest values — timber, water, recreation, wildlife, and grazing.

The forests have important beneficial influences in stabilizing streamflow and in controlling sediment. Also, opening some coniferous forests can have significant effects on water yield. Research on the Fraser Experimental Forest[14] and elsewhere provides some evidence that it is possible to improve water yields and seasonal distribution of runoff by carefully planned logging (*7*). On the White River Plateau streamflow increased about 25 percent following the extensive kill of spruce by the Engelmann beetle (*16*). Cutting in the fir-spruce and lodgepole pine types can greatly affect streamflows and consequently water project plans, reservoir design and operation, power generation, and other facilities and uses (*11*). Although logging inevitably causes soil disturbance and silt movement, proper application of control measures can prevent serious effects on water quality.

Effects of logging on recreation, wildlife, and grazing are very complex and are not well documented for Colorado. It is possible, however, to mention a few general results that may be expected from controlled harvesting. Scenic and other recreational values need not be impaired if timber is removed gradually along roads and waterways. This is the current practice on most public lands. Harvesting of high risk timber tends to minimize blowdown and insect devastation, and the subsequent danger of big fires. The practice of clear cutting in small areas can favor habitat conditions for wildlife by increasing edge environment, interspersion of vegetation types, and amount, variety, and distribution of food vegetation. Many access roads needed for timber cutting will permit fuller development of other values — and if timber foots much of construction cost, many roads will be built sooner than they otherwise would.

These examples of effects of timber cutting on other forest values and the indicated complex resource relationships illustrate the big problems facing timber managers in meeting future demands on Colorado's forests. There is little doubt that these demands will be big — much bigger than heretofore. Underlying these expected increases in demand is, of course, a predicted increase in population from the present 190 million to about 329 million by 2000. Forecasts of increased timber demands, sharp upward trends in water, recreation, and wildlife use in recent year, and use of grazing lands at or near current capacity all portend heavy future use. Is can be expected that Colorado's forests will be called on to make much bigger contributions to the Nation's output of timber and other forest benefits than they have in the past.

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APPENDIX

TERMINOLOGY

Forest Land

The term *forest land* includes (a) land which is at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking, and which has not been developed for other use; (c) afforested areas.

At the time the fieldwork for this report was performed, the minimum unit of area for forest land classification was 10 acres with a minimum width of stringer strips of 120 feet.

The principal classes of forest land are:

Commercial forest land. — Forest land which is (a) producing, or is physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; (c) not withdrawn from timber utilization.

Noncommercial forest land. — Three classes of noncommercial forest land are recognized: *Productive-reserved, Unproductive-nonreserved, and Unproductive-reserved.*

Productive-reserved is public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

Unproductive indicates forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions or forest land so physically inaccessible as to be unavailable economically in the foreseeable future.

Forest Types

Forest land is classified into types on the basis of tree species; the type name is that of the predominant species. The predominant species is the one which has a plurality of (a) gross cubic volume in sawtimber and poletimber stands, or (b) the number of stems in seedling and sapling stands. Both growing stock and cull trees are considered in the classification. Forest types which occur on both commercial and noncommercial forest land are:

Douglas-fir
Ponderosa pine
Lodgepole pine
Limber pine
Bristlecone pine
Fir-spruce
Aspen
Cottonwood

Two additional forest types which occur only on noncommercial forest land are:
Pinyon-juniper
Chaparral

Tree-Size Classes

Sawtimber-size tree
A tree 11.0 inches d.b.h. or larger

Pole-size tree
A tree 5.0 to 10.9 inches d.b.h.

Seedling-sapling trees
Trees at least 1 foot high and less than 5.0 inches d.b.h.

Tree-Merchantability Classes

Sawtimber tree

Live tree of commercial species, 11.0 inches d.b.h. or larger, that contains at least one 10-foot log to a merchantable top diameter and having the likelihood of eventually containing at least a 16-foot minimum saw log. Also, at least one-third of the board-foot volume must be free from rot or other defect.

Poletimber tree
Live tree of commercial species, 5.0 to 10.9 inches d.b.h., free of rot and having the likelihood of growing into a sawtimber tree.

Sapling and seedling trees
Live trees of commercial species, less than 5.0 inches d.b.h., with form and quality to qualify as potential poletimber trees.

Growing stock trees
Sawtimber trees, poletimber trees, saplings and seedlings; i.e., all live trees except cull trees.

In discussion and tables on volumes, growth, and mortality, the term *growing stock* refers only to sawtimber trees and poletimber trees; i.e., all live trees 5 inches d.b.h. and larger (except cull trees). Saplings and seedlings are not part of growing stock in this usage of the term.

Cull tree
Live tree of sawtimber or poletimber size that is unmerchantable for saw logs, now or prospectively, because of rot or other defect, or species.

Sound cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull with at least one-half of this cull the result of sweep, crook, or other sound defect. Also included are sound trees which do not contain at least one 10-foot saw log.

b. Poletimber-size trees that are unlikely to grow into sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, crooks, or girdling by porcupine. No rot may be present.

Rotten cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull, with more than half of the cull due to rot.

b. Poletimber-size trees showing any evidence of rot in the main stem.

Mortality tree
A tree 5.0 inches d.b.h. or larger, standing or down, which has died within the past 5 years and was not a cull tree at time of death.

Salvable dead tree
Dead tree 5.0 inches d.b.h. or larger, standing or down (but not lying on the ground) which has 50 percent of more of its cubic-foot volume in sound wood.

Stand-Size Classes

Sawtimber stands
A stand with a minimum net volume per acre of 1,500 board feet (International ¼-inch rule) in sawtimber trees. Two classes of sawtimber stands are recognized:

Large sawtimber.—A stand in which the majority of the net board-foot volume is in sawtimber trees 21.0 inches d.b.h. and larger.

Small sawtimber.—A stand in which the majority of the net board-foot volume is in sawtimber trees from 11.0 to 20.9 inches d.b.h.

Poletimber stand
Stand failing to meet the sawtimber stand specifications, but at least 10 percent stocked with poletimber and larger (5.0 inches d.b.h. and larger) trees and with at least half the stocking in poletimber trees.

Seedling and sapling stand
A stand not qualifying as either a sawtimber or poletimber stand, but having at least 10 percent stocking of trees of commercial species and with at least half the stocking in seedling and sapling trees.

Nonstocked area
An area not qualifying as a sawtimber, poletimber, or a seedling-sapling stand; i.e.,

normally an area less than 10 percent stocked.

Stocking

Stocking is a measure of the degree to which growing space is utilized by trees. In this report it is expressed as the percentage of the available space that is occupied by tree crowns as viewed on aerial photographs.

Well-stocked stand

A stand that is 70 percent or more covered by tree crowns.

Medium-stocked stand

A stand with 40 to 70 percent coverage by tree crowns.

Poorly stocked stand

A stand with 10 to 40 percent coverage by tree crowns.

Nonstocked area

An area with less than 10 percent coverage by tree crowns.

Timber Volume

All-timber volume

Volume in cubic feet of sound wood in the bole of growing stock, cull, and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top inside bark.

Growing stock volume

Net volume in cubic feet of sawtimber trees and poletimber trees from stump to a minimum 4.0-inch top inside bark.

Live sawtimber volume

Net volume in board feet, International ¼-inch rule, of the saw log portion of sawtimber trees.

Saw log portion

That portion of the bole of sawtimber trees between the stump and the merchantable top.

Merchantable top

The point at which the upper limit of saw log merchantability is limited either by limbs or by a minimum diameter. The latter varies with diameter class, ranging from 5 inches inside bark for trees 11 inches at breast height to 10 inches for trees 26 inches or larger.

Upper-stem portion

That part of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches inside bark.

Quality class

A classification of sawtimber volume in terms of log grades. Four grades are recognized and distinguished by the occurrence and characteristics of knots. The log grades corresponding to the quality classes are:

Grade 1 (select logs) are essentially smooth and surface clear, except that in logs 16 inches and larger in diameter a few visible knots are permitted, providing there are no more than 1 large knot, or 2 medium or small knots, or 4 pin knots. Knot sizes for all grades are:

Pin knots—0.5 inch or less
Small knots—0.5 to 0.75 inch
Medium knots—0.75 to 1.5 inches
Large knots—over 1.5 inches

Occasional logs having a greater number of knots are admitted provided these knots may be boxed in an area not exceeding one-third the area of one face or an equivalent area of two faces.

Grade 2 (shop logs) display relatively few knots of any size, so spaced that at least 50 percent of the surface of the log is in smooth, clear areas, the size of which must be at least one-fourth the girth of the log in width, by 4 feet or more in length.

A log with no more than 12 medium or smaller knots, or more than 8 large ones, may be immediately classed as grade 2. If this number of knots is exceeded, the clear area basis governs.

Grade 3 (common logs) display either (a) pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab, or (b) 16 dead knots (an average of 4 per face) averaging medium in size.

Grade 4 (low common logs) display medium, large, and very large live and/or dead knots in excess of the numbers permitted in grades 2 and 3.

Growth

Net annual growth of sawtimber or growing stock

The average annual change, calculated from the total change over a 10-year period, in net board-foot or cubic-foot volume of live sawtimber or growing stock on commercial forest land.

Mortality

Net annual mortality of sawtimber or growing stock

The average annual net board-foot or cubic-foot volume removed from live sawtimber or growing stock through death, calculated from the total net volume removed by such causes over a 10-year period.

Timber Cut

Timber cut from growing stock

The volume of sound wood in live sawtimber and poletimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Timber cut from sawtimber

The net board-foot volume of live sawtimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Logging residues from growing stock

The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging on commercial forest land and not converted to timber products.

Ownership Classes

National Forest lands

Federal lands which have been designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Other Federal lands

Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies.

State lands

Lands owned by the State.

Forest industry lands

Lands owned by companies or individuals operating wood-using plants.

Farmer-owned lands

Lands owned by operators of farms.

Miscellaneous private lands

Privately owned lands other than forest-industry or farmer-owned lands.

Principal Tree Species

	Softwoods
Douglas-fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Fir, corkbark	*A. lasiocarpa arizonica*
Fir, white	*A. concolor*
Juniper	*Juniperus spp.*
Pine, bristlecone	*Pinus aristata*
Pine, limber	*P. flexilis*
Pine, lodgepole	*P. contorta*
Pine, ponderosa	*P. ponderosa*
Spruce, Engelmann	*Picea engelmannii*
Spruce, blue	*P. pungens*
	Hardwoods
Aspen, quaking	*Populus tremuloides*
Cottonwood, black	*Populus trichocarpa*

SURVEY METHODS

Area statistics were determined by two methods: (1) On National Forests, forest lands were mapped on aerial photographs according to type, stand size, and crown density. Photo delineations were then transferred to base maps. Non-National Forest lands within National Forest were delineated on the maps according to the ownership class. Maps were then dot-counted to obtain the estimates of area by the various land and forest classes and by ownership. (2) For lands outside National Forests a sampling procedure was used. Points were classified on aerial photos to determine the proportion of area by forest versus nonforest, class of forest, and ownership. A percentage of the points was checked on the ground for correctness of classification. Results of the field check were then used to adjust the map and photo estimates of proportions. Acreages were determined by applying the adjusted proportions to the area outside National Forests.

Volume estimates are based on tree measurements taken on 2,196 sample areas located at random on commercial forest lands. Sample locations were pricked on aerial photos then located on the ground and established on a permanent basis to permit remeasurement on future surveys. Each location consisted of a pair of circular plots, 5 chains apart. Each plot consisted of four circular subplots with a common center. The area of subplots and kind of trees tallied on them are as follows:

1/500 acre — live seedling-sapling-size trees
1/50 acre — live pole-size trees
1/5 acre — live sawtimber-size trees, and all salvable dead trees (pole-size and saw-timber-size)
1/3 acre — mortality trees of pole-size and larger

In addition to making the customary measurements and classifications of trees for volume and quality, increment borings were taken for growth estimates.

Formulas equating field measurements to volume, growth, and mortality were applied as part of the machine data processing to provide average volumes per acre for the various classifications based on type, size, stocking, etc. These averages, applied to area estimates, provided volumes shown in statistical tables.

Estimates of timber cut are based on periodic surveys of forest industries. The latest surveys are for 1962 and are the basis for data shown in the appendix tables. Utilization trends discussed in the text are based mainly on lumber production data, since complete information on output of all products for years prior to 1957 is not available. Data for estimating the volume of logging residues are obtained by special studies on active woods operations.

RELIABILITY OF ESTIMATES

Data collected by sampling are not entirely reliable; i.e., there is a sampling error. Sufficient samples are taken to insure that the error is not above a specified maximum. Magnitude of the errors associated with area and volume estimates for Colorado have been determined by statistical analysis of the data.

Estimates of acreage of the various classes of forest land were determined by two procedures — mapping (11.8 million acres) and sampling (10.8 million acres). There are no sampling errors for the mapped area. Sampling errors for the sampled portion and for the total estimates of commercial and noncommercial breakdowns are shown in the following tabulation:

	Mapped area		Sampled area			Total forest area		
	Area M acres	*SE*	*Area M acres*	*SE Acres*	*SE Percent*	*Area M acres*	*SE Acres*	*SE Percent*
Commercial	9,149	0	3,126	41,888	1.34	12,275	41,888	0.34
Noncommercial	2,614	0	7,694	148,492	1.93	10,308	148,492	1.44
Total	11,763		10,820			22,583		

The sampling error for the estimated 17,337 million cubic feet of growing stock in Colorado is ±1.8 percent.

The sampling error for the total timber cut in 1962 from growing stock (37,556 cubic feet) is estimated at ±2.1 percent.

All errors are computed on the basis of odds of two out of three that values which would result from a 100-percent cruise would lie within the range indicated by the error.

APPENDIX TABLES

Table 1.—**Area by land classes, Colorado, 1959**

Land class	Thousand acres
Commercial forest land	12,275
Unproductive forest land	9,843
Productive-reserved forest land	465
Total forest land	22,583
Nonforest land	43,927
All land	[1]66,510

[1] *From U.S. Bureau of the Census, Land and Water Areas of the United States, 1950.*

Table 2.—**Area of commercial forest land by ownership classes, Colorado, 1959**

Ownership class	Thousand acres
National Forest	8,384
Other Federal:	
Bureau of Land Management	415
Indian	103
Miscellaneous Federal	5
Total other Federal	523
State	190
County and municipal	45
Farmer-owned	2,649
Miscellaneous private[1]	484
All ownerships	12,275

[1] *Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 3.—**Area of commercial forest land by stand-size and ownership classes, Colorado, 1959**

Stand-size class	All ownerships	National Forest	Other public	Farmer[1] and misc. private
	Thousand acres			
Sawtimber stands:				
Large sawtimber	449	388	38	23
Small sawtimber	5,903	4,252	393	1,258
Total	6,352	4,640	431	1,281
Poletimber stands	4,990	3,240	300	1,450
Sapling and seedling stands	499	342	20	137
Nonstocked areas	434	162	7	265
All classes	12,275	8,384	758	3,133

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 4.—**Area of commercial forest land, by stand-size volume classes for sawtimber and other stand-size classes, Colorado, 1959**

Stand volumes per acre[1]	Area by stand-size classes		
	All stands	Sawtimber stands	Other stands
	Thousand acres		
Less than 1,500 board feet	5,090	8	5,082
1,500 to 5,000 board feet	4,436	3,599	837
5,000 to 10,000 board feet	968	964	4
10,000 to 20,000 board feet	1,774	1,774	—
More than 20,000 board feet	7	7	—
All classes	12,275	6,352	5,923

[1] *Net volume, International ¼-inch rule.*

Table 5.—**Area of commercial forest land, by stocking classes of all live trees and by stand-size classes, Colorado, 1959**

Stocking class	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
70 percent or more	3,561	1,741	1,658	162	—
40 to 70 percent	5,789	3,099	2,395	295	—
10 to 40 percent	2,491	1,512	937	42	—
Less than 10 percent	434	—	—	—	434
All classes	12,275	6,352	4,990	499	434

Table 6.—**Area of commercial forest land, by forest types and ownership classes, Colorado, 1959**

Forest type	All ownerships	Public ownerships	Private ownerships
	Thousand acres		
Douglas-fir	1,451	1,056	395
Ponderosa pine	2,347	1,180	1,167
Lodgepole pine	2,068	1,693	375
Limber and bristlecone pine	139	98	41
Fir-spruce	3,393	3,067	326
Aspen	2,794	2,025	769
Cottonwood	83	23	60
All types	12,275	9,142	3,133

Table 7.—Area of commercial forest land by forest types and by stand-size classes, Colorado, 1959

Forest type	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
Douglas-fir	1,451	1,046	397	4	4
Ponderosa pine	2,347	1,504	553	5	285
Lodgepole pine	2,068	714	1,252	95	7
Limber pine[1]	139	62	73	3	1
Fir-spruce	3,393	2,746	485	27	135
Aspen	2,794	201	2,226	365	2
Cottonwood	83	79	4	(2)	(2)
All types	12,275	6,352	4,990	499	434

[1] *Includes the area of bristlecone pine.*

[2] *Less than 0.5 thousand acres.*

Table 8.—Area of noncommercial forest land, by forest types, Colorado, 1959

Forest type	All areas	Productive reserved areas	Unproductive areas
	Thousand acres		
Douglas-fir	15	15	(1)
Ponderosa pine	22	22	—
Lodgepole pine	89	89	—
Limber pine[2]	10	(1)	10
Fir-spruce	341	315	26
Aspen	341	24	317
Cottonwood	(1)	(1)	—
Chaparral	3,704	—	3,704
Pinyon-juniper	4,674	(1)	4,674
Other	1,112	—	1,112
All types	10,308	465	9,843

[1] *Less than 0.5 thousand acres.*

[2] *Includes the area of bristlecone pine.*

Table 9.—**Number of growing-stock trees on commercial forest land, by diameter classes and by softwoods and hardwoods, Colorado, 1959**

D.B.H. class (inches)	All species	Softwood	Hardwood
	Thousand trees		
1.0- 2.9	2,143,927	1,195,509	948,418
3.0- 4.9	1,650,491	832,373	818,118
5.0- 6.9	869,598	549,654	319,944
7.0- 8.9	482,383	354,717	127,666
9.0-10.9	261,666	220,327	41,339
11.0-12.9	141,913	125,164	16,749
13.0-14.9	84,814	76,822	7,992
15.0-16.9	49,008	45,350	3,658
17.0-18.9	27,510	25,791	1,719
19.0-28.9	32,804	31,694	1,110
29.0-38.9	1,787	1,787	—
39.0 and larger	58	58	—
All classes	5,745,959	3,459,246	2,286,713

Table 10.—**Number of cull and salvable dead trees on commercial forest land, by diameter groups and by softwoods and hardwoods, Colorado, 1959**

D.B.H. class (inches)	Cull trees	Salvable dead trees
	Thousand trees	
Softwoods:		
5.0- 8.9	58,929	80,351
9.0-18.9	24,144	84,343
19.0 and larger	2,380	8,919
Total	85,453	173,613
Hardwoods:		
5.0-10.9	255,030	38,032
11.0-18.9	8,480	2,692
19.0 and larger	312	94
Total	263,822	40,818
All species	349,275	214,431

Table 11.—Volume of timber on commercial forest land, by class of timber and by softwoods and hardwoods, Colorado, 1959

Class of timber	All species	Softwoods	Hardwoods
		Thousand cubic feet	
Sawtimber trees:			
Saw-log portion	8,807,057	8,274,777	532,280
Upper-stem portion	922,261	756,035	166,226
Total	9,729,318	9,030,812	698,506
Poletimber trees[1]	7,607,288	5,866,135	1,741,153
All growing-stock trees	17,336,606	14,896,947	2,439,659
Sound cull trees:			
Sawtimber-size trees	41,441	37,424	4,017
Poletimber-size trees	234,757	183,165	51,592
Total	276,198	220,589	55,609
Rotten cull trees:			
Sawtimber-size trees	297,054	183,784	113,270
Poletimber-size trees	875,241	98,568	776,673
Total	1,172,295	282,352	889,943
Salvable dead trees:			
Sawtimber-size trees	2,390,611	2,317,901	72,710
Poletimber-size trees	938,457	785,005	153,452
Total	3,329,068	3,102,906	226,162
All timber	22,114,167	18,502,794	3,611,373

[1] *Poletimber trees are trees 5.0 inches d.b.h. to 10.9 inches d.b.h.*

Table 12.—Volume of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Colorado, 1959

Ownership class	All species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
National Forest	13,796	12,044	1,752
Other public	782	650	132
Farmer and misc. private[1]	2,759	2,203	556
All ownerships	17,337	14,897	2,440
		SAWTIMBER *(Million board feet)*[2]	
National Forest	43,231	40,573	2,658
Other public	2,172	1,920	252
Farmer and misc. private[1]	7,328	6,457	871
All ownerships	52,731	48,950	3,781

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.*

Table 13.—**Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, Colorado, 1959**

Stand-size class	All species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
Sawtimber stands	12,562	11,818	744
Poletimber stands	4,635	2,982	1,653
Sapling and seedling stands	107	65	42
Nonstocked areas	33	32	1
All classes	17,337	14,897	2,440
		SAWTIMBER *(Million board feet)*[1]	
Sawtimber stands	46,477	44,206	2,271
Poletimber stands	6,052	4,561	1,491
Sapling and seedling stands	83	64	19
Nonstocked areas	119	119	—
All classes	52,731	48,950	3,781

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.*

Table 13a.—**Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by species, Colorado, 1959**

Stand-size class	All species	Douglas-fir	Ponderosa pine	Lodgepole pine	Limber pine[1]	True firs[2]	Spruce[3]	Other softwoods	Aspen	Cottonwood	Other hardwoods
						GROWING STOCK *(Million cubic feet)*					
Sawtimber stands	12,562	1,216	805	1,675	131	2,117	5,873	1	665	75	4
Poletimber stands	4,635	365	192	1,574	56	282	512	1	1,650	1	2
Sapling and seedling stands	107	9	4	37	2	6	7	—	42	—	—
Nonstocked areas	33	—	16	(4)	—	4	12	—	1	—	—
All classes	17,337	1,590	1,017	3,286	189	2,409	6,404	2	2,358	76	6
						SAWTIMBER *(Million board feet)*[5]					
Sawtimber stands	46,477	4,649	3,264	4,644	392	6,358	24,899	—	1,975	285	11
Poletimber stands	6,052	752	432	1,365	73	427	1,512	—	1,488	3	—
Sapling and seedling stands	83	10	13	15	7	8	11	—	19	—	—
Nonstocked areas	119	—	74	—	—	4	41	—	—	—	—
All classes	52,731	5,411	3,783	6,024	472	6,797	26,463	—	3,482	288	11

[1] *Includes a minor volume of bristlecone pine.*
[2] *Subalpine and white firs.*
[3] *Engelmann and blue spruce.*
[4] *Less than 0.5 million cubic feet.*
[5] *International ¼-inch log rule. Volumes are for trees 11.0 inches d.b.h and larger.*

Table 14.—Volume of growing stock on commercial forest land, by species and diameter groups, Colorado, 1959

Species	Diameter group (inches at breast height)					
	All classes	5.0 to 10.9	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million cubic feet					
Softwoods:						
Douglas-fir	1,590	555	757	209	67	2
Ponderosa pine	1,017	208	581	174	53	1
Lodgepole pine	3,286	2,191	1,075	20	—	—
Limber pine[1]	189	97	84	8	—	—
White fir	328	76	147	99	6	—
Subalpine fir	2,081	1,026	985	68	2	—
Spruce[2]	6,404	1,712	3,591	1,037	64	—
Other softwoods	2	1	1	—	—	—
Total	14,897	5,866	7,221	1,615	192	3
Hardwoods:						
Aspen	2,358	1,720	631	7	—	—
Cottonwood	76	17	48	11	—	—
Other hardwoods	6	4	2	(3)	—	—
Total	2,440	1,741	681	18	—	—
All species	17,337	7,607	7,902	1,633	192	3

[1] *Includes a minor volume of bristlecone pine.*
[2] *Engelmann and blue spruce.*
[3] *Less than 0.5 million cubic feet.*

Table 14a.—Volume of sawtimber on commercial forest land, by International ¼-inch log rule, species, and diameter groups, Colorado, 1959

Species	Diameter group (inches at breast height)				
	All classes	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million board feet				
Softwoods:					
Douglas-fir	5,411	3,801	1,207	393	10
Ponderosa pine	3,783	2,586	850	344	3
Lodgepole pine	6,024	5,910	114	—	—
Limber pine[1]	472	432	40	—	—
White fir	1,342	751	557	34	—
Subalpine fir	5,455	5,069	375	11	—
Spruce[2]	26,463	19,885	6,174	401	3
Other softwoods	—	—	—	—	—
Total	48,950	38,434	9,317	1,183	16
Hardwoods:					
Aspen	3,482	3,445	37	—	—
Cottonwood	288	234	54	—	—
Other hardwoods	11	9	2	—	—
Total	3,781	3,688	93	—	—
All species	52,731	42,122	9,410	1,183	16

[1] *Includes a minor volume of bristlecone pine.*
[2] *Engelmann and blue spruce.*

Table 14b.—Volume of sawtimber on commercial forest land by Scribner log rule, species, and diameter groups, Colorado, 1959

Species	Diameter group (inches at breast height)				
	All classes	11.0 to 20.9	21.0 to 30.9	31.0 to 40.9	41.0 and larger
	Million board feet				
Softwoods:					
Douglas-fir	4,550	3,122	1,059	359	10
Ponderosa pine	3,043	2,006	718	316	3
Lodgepole pine	5,020	4,918	102	—	—
Limber pine[1]	386	350	36	—	—
White fir	1,156	629	496	31	—
Subalpine fir	4,614	4,270	334	10	—
Spruce[2]	22,862	17,011	5,482	367	2
Other softwoods	—	—	—	—	—
Total	41,631	32,306	8,227	1,083	15
Hardwoods:					
Aspen	2,966	2,933	33	—	—
Cottonwood	245	197	48	—	—
Other hardwoods	10	8	2	—	—
Total	3,221	3,138	83	—	—
All species	44,852	35,444	8,310	1,083	15

[1] *Includes a minor volume of bristlecone pine.*
[2] *Engelmann and blue spruce.*

Table 15.—Volume of sawtimber on commercial forest land, by species[1] and quality classes, Colorado, 1959

Species	All classes	Quality classes			
		1	2	3	4
	Million board feet[2]				
Softwoods:					
Ponderosa pine	3,783	138	258	792	2,595
Total	3,783	138	258	792	2,595

[1] *Ponderosa pine is the only species graded.*
[2] *International -inch rule. Volumes are for trees 11.0 inches d.b.h. or larger.*

Table 16.—Volume of salvable dead sawtimber-size trees on commercial forest land, by softwoods and hardwoods, Colorado, 1959

Species group	Volume
	Thousand board feet[1]
Softwoods	12,779 ,000
Hardwoods	393 000
All species	13,172

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.*

Table 17.—Net annual growth and annual cut of growing stock on commercial forest land, by species, Colorado

Species	Net annual growth 1959	Annual timber cut 1962
	Thousand cubic feet	
Softwoods:		
Douglas-fir	8,385	1,410
Ponderosa pine	14,992	4,269
Lodgepole pine	44,299	12,611
True firs	−9,831	1,183
Spruce[1]	63,625	16,415
Other softwoods	2,297	0
Total	123,767	35,888
Hardwoods	37,589	1,668
All species	161,356	37,556

[1] *Engelmann and blue spruce.*

Table 18.—Net annual growth and annual cut of sawtimber on commercial forest land, by species, Colorado

Species	Net annual growth 1959	Annual timber cut 1962
	Thousand board feet[1]	
Softwoods:		
Douglas-fir	−895	7,574
Ponderosa pine	58,486	23,112
Lodgepole pine	70,753	68,364
True firs	−75,027	6,409
Spruce[2]	269,047	88,757
Other softwoods	6,858	0
Total	329,222	194,216
Hardwoods	90,513	1,385
All species	419,735	195,601

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.*

[2] *Engelmann and blue spruce.*

Table 19.—Net annual growth and annual cut of growing stock on commercial forest land, by ownership classes and by softwoods and hardwoods, Colorado

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
	NET ANNUAL GROWTH, 1959 *(Thousand cubic feet)*			
Softwoods	123,767	89,235	7,657	26,875
Hardwoods	37,589	30,159	1,542	5,888
All species	161,356	119,394	9,199	32,763
	ANNUAL TIMBER CUT, 1962 *(Thousand cubic feet)*			
Softwoods	35,888	29,393	3,445	3,050
Hardwoods	1,668	1,366	160	142
All species	37,556	30,759	3,605	3,192

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 20.—**Net annual growth and annual cut of sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Colorado**

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
		NET ANNUAL GROWTH, 1959 *(Thousand board feet)*[2]		
Softwoods	329,222	235,469	23,577	70,176
Hardwoods	90,513	60,892	5,478	24,143
All species	419,735	296,361	29,055	94,319
		ANNUAL TIMBER CUT, 1962 *(Thousand board feet)*[2]		
Softwoods	194,216	159,063	18,645	16,508
Hardwoods	1,385	1,134	133	118
All species	195,601	160,197	18,778	16,626

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.*

Table 21.—**Annual mortality of growing stock and sawtimber on commercial forest land, by species, Colorado, 1959**

Species	Growing stock	Sawtimber
	Thousand cubic feet	*Thousand board feet*[1]
Softwoods:		
Douglas-fir	14,968	82,679
Ponderosa pine	3,967	20,178
Lodgepole pine	12,593	42,509
True firs	54,844	219,133
Spruce	20,439	108,835
Other softwoods	269	1,133
Total	107,080	474,467
Hardwoods	33,191	75,051
All species	140,271	549,518

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.*

[2] *Engelmann and blue spruce.*

Table 22.—**Annual mortality of growing stock and sawtimber on commercial forest land by ownership classes and by softwoods and hardwoods, Colorado, 1959**

Ownership class	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	Thousand cubic feet			*Thousand board feet*[1]		
National Forest lands	108,740	88,049	20,691	451,378	399,141	52,237
Other public lands	5,916	3,700	2,216	18,010	14,129	3,881
Farmer and miscellaneous private lands[2]	25,615	15,331	10,284	80,130	61,197	18,933
All ownerships	140,271	107,080	33,191	549,518	474,467	75,051

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.*

[2] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 23.—Annual mortality of growing stock and sawtimber on commercial forest land, by causes and by softwoods and hardwoods, Colorado, 1959

Cause of death	Growing stock			Sawtimber		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	Thousand cubic feet			*Thousand board feet*[1]		
Fire	279	266	13	1,076	1,074	2
Insects	45,301	44,743	558	204,574	202,815	1,759
Disease	70,650	42,436	28,214	248,193	185,122	63,071
Other	20,156	16,715	3,441	81,930	74,390	7,540
Unknown	3,885	2,920	965	13,745	11,066	2,679
All causes	140,271	107,080	33,191	549,518	474,467	75,051

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger.*

Table 24.—Total output of timber products by products, by type of material used, and by softwoods and hardwoods, Colorado, 1962

Product and species group	Total output in standard units		Output from roundwood from growing stock		Output from roundwood from nongrowing stock sources		Output from plant byproducts (standard units)
	Unit	Number	Standard units	M cubic feet	Standard units	M cubic feet	
Saw logs:							
Softwood	M bd. ft.[1]	183,490	177,251	30,300	6,239	1,066	0
Hardwood	M bd. ft.[1]	1,155	1,116	190	39	7	0
Total	M bd. ft.[1]	184,645	178,367	30,490	6,278	1,073	0
Pulpwood:[2]							
Poles:							
Softwood	M pieces	53	53	482	0	0	0
Hardwood	M pieces	0	0	0	0	0	0
Total	M pieces	53	53	482	0	0	0
Mine timbers:							
Softwood	M cu. ft.	1,409	1,329	1,329	80	80	0
Hardwood	M cu. ft.	2	2	2	0	0	0
Total	M cu. ft.	1,411	1,331	1,331	80	80	0
Miscellaneous industrial wood[3]							
Softwood	M cu. ft.	605	409	409	196	196	0
Hardwood	M cu. ft.	1,341	1,331	1,331	10	10	0
Total	M cu. ft.	1,946	1,740	1,740	206	206	0
Posts:							
Softwood	M pieces	368	361	323	7	6	0
Hardwood	M pieces	0	0	0	0	0	0
Total	M pieces	368	361	323	7	6	0
Fuelwood:							
Softwood	M std. cords	26	0	0	8	549	18
Hardwood	M std. cords	2	0	0	2	153	0
Total	M std. cords	28	0	0	10	702	18
All products:							
Softwood		0	0	32,843	0	1,897	0
Hardwood		0	0	1,523	0	170	0
Total		0	0	34,366	0	2,067	0

[1] *International ¼-inch rule.*
[2] *Included in miscellaneous industrial wood to avoid disclosure of a single operation.*
[3] *Includes excelsior bolts, house logs, match-splintlogs, pulpwood.*

Table 25.—**Total output of roundwood products, by source and by softwoods and hardwoods, Colorado, 1962**

Source	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Growing-stock trees:[1]			
Sawtimber trees	27,520	27,293	227
Poletimber trees	6,846	5,550	1,296
Total	34,366	32,843	1,523
Cull trees[1]	0	0	0
Salvable dead trees[1]	2,067	1,987	170
Other sources[2]	0	0	0
All sources	36,433	34,740	1,693

[1] *On commercial forest land.*

[2] *Includes noncommercial forest land, nonforest land such as fence rows, trees less than 5.0 inches in diameter, and treetops and limbs.*

Table 26.—**Annual timber cut from growing stock on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Colorado, 1962**

Products and residues	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Roundwood products:			
Saw logs	30,490	30,300	190
Poles	482	482	0
Mine timbers	1,331	1,329	2
Miscellaneous industrial wood	1,740	409	1,331
Posts	323	323	0
All products	34,366	32,843	1,523
Logging residues	3,190	3,045	145
Timber cut	37,556	35,888	1,668

Table 27.—**Annual timber cut from live sawtimber on commercial forest land, by products and logging residues and by softwoods and hardwoods, Colorado, 1962**

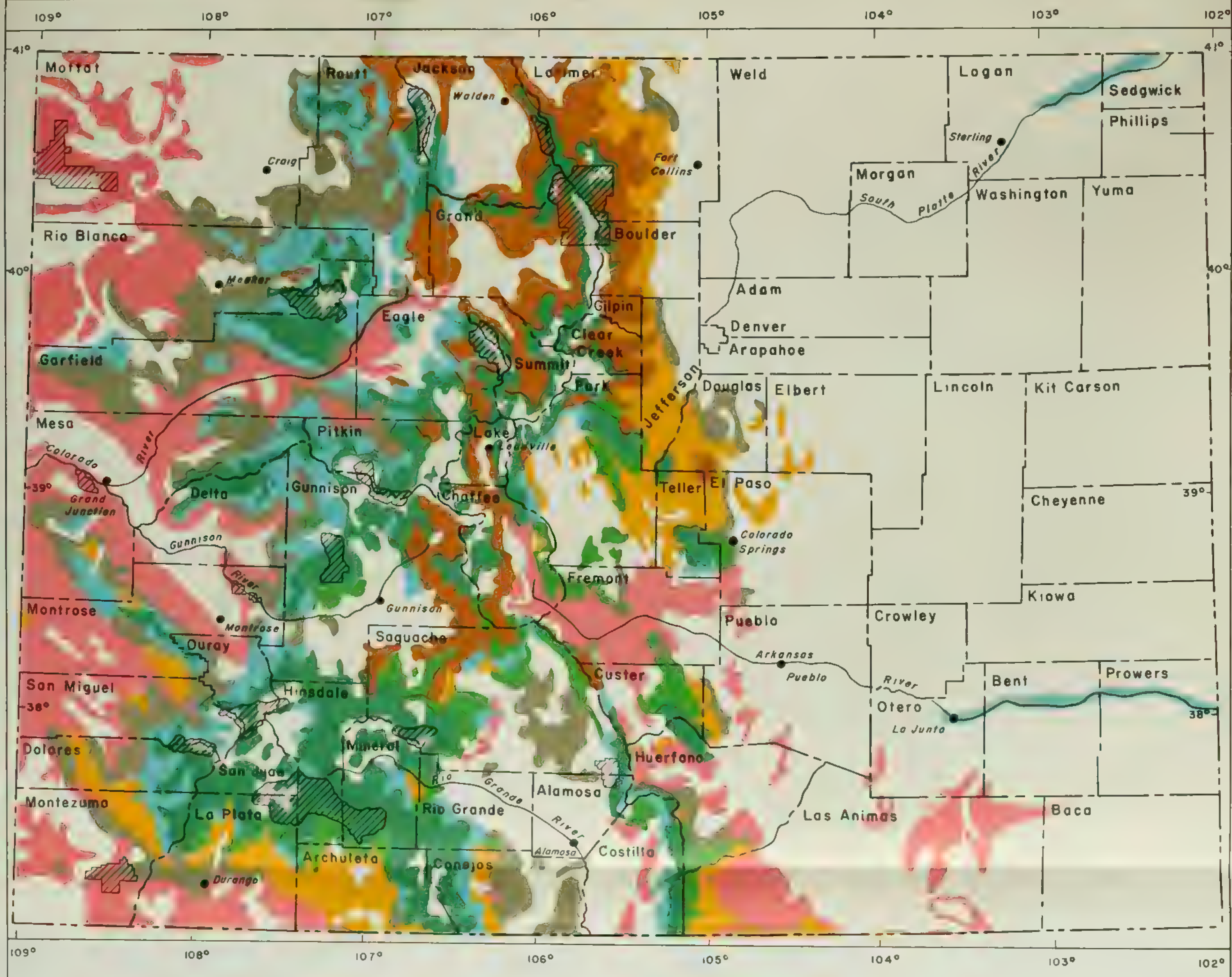
Products and residues	All species	Softwoods	Hardwoods
	Thousand board feet[1]		
Roundwood products:			
Saw logs	178,367	177,251	1,116
Poles	2,820	2,820	0
Mine timbers	391	385	6
Miscellaneous industrial wood	533	326	207
Posts	1,105	1,105	0
All products	183,216	181,887	1,329
Logging residues	12,385	12,329	56
Timber cut	195,601	194,216	1,385

[1] *International ¼-inch rule.*

Table 28.—**Volume of plant residues by industrial source and type of residue, and by softwoods and hardwoods, Colorado, 1962**

Industrial source	Species and character of residues								
	All species			Softwoods			Hardwoods		
	Total	Coarse[1]	Fine[2]	Total	Coarse	Fine	Total	Coarse	Fine
	Thousand cubic feet								
Lumber industry	15,019	7,436	7,583	14,929	7,391	7,538	90	45	45
Veneer and plywood industry	0	0	0	0	0	0	0	0	0
Other primary industries	856	856	0	300	300	0	556	556	0
All industries	15,875	8,292	7,583	15,229	7,691	7,538	646	601	45

[1] *Unused material suitable for chipping, such as slabs, edgings, and veneer cores.*
[2] *Unused material not suitable for chipping, such as sawdust and shavings.*



MAJOR FOREST TYPES
COLORADO
1963

FOREST SURVEY - ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
AND
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
U S DEPARTMENT OF AGRICULTURE - FOREST SERVICE

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Scale in Miles

LEGEND

🟫 LODGEPOLE PINE	▭ HARDWOODS	▨ CHAPARRAL
🟩 FIR - SPRUCE	🟧 PONDEROSA PINE	☐ NONFOREST
🟩 DOUGLAS FIR	🟥 PINYON - JUNIPER	▨ AREAS RESERVED FROM TIMBER CUTTING

WOOD · WATER · FORAGE · WILDLIFE · RECREATION
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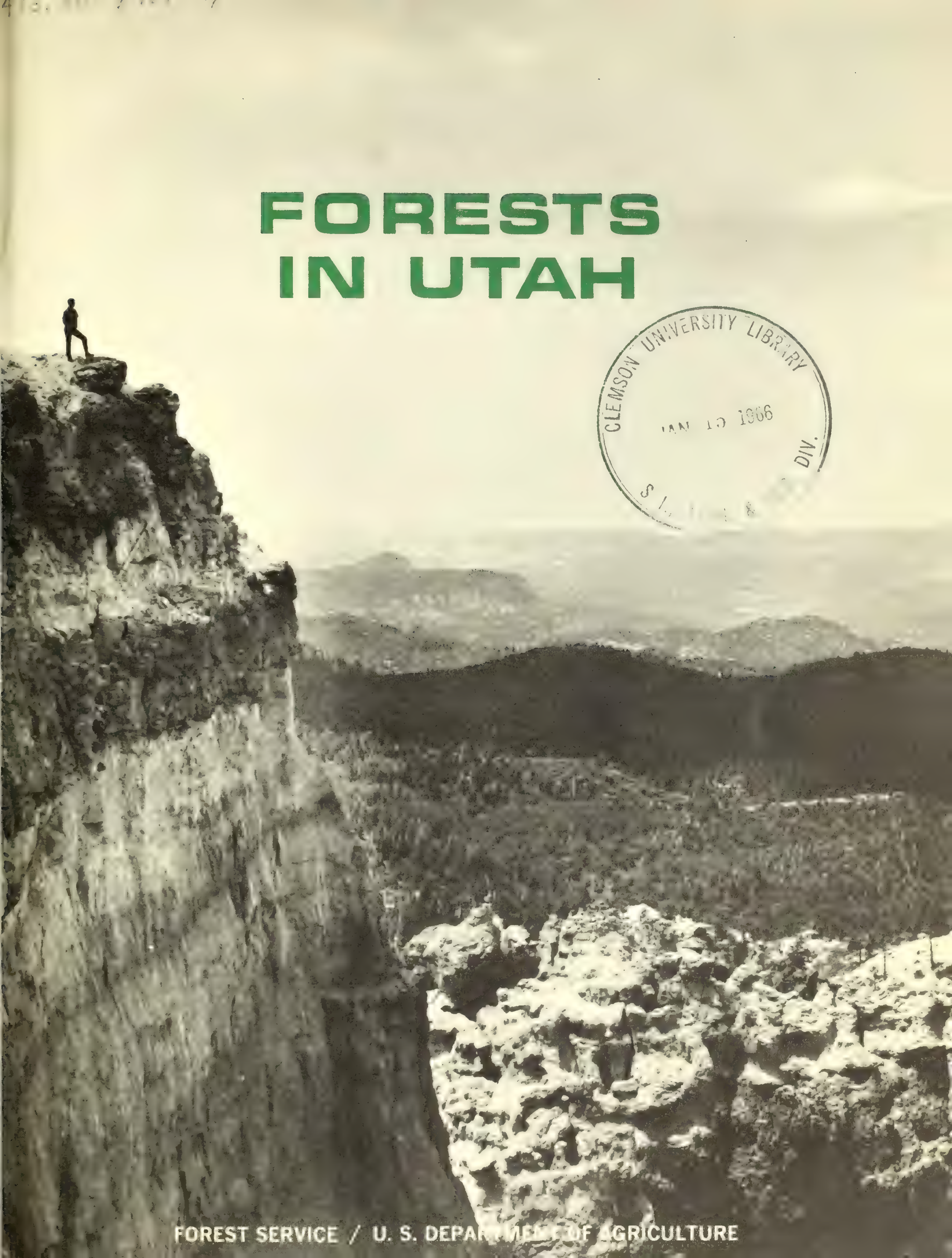
FORESTS IN UTAH



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THE AUTHOR

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COVER PHOTO

View from Strawberry Point, Dixie National Forest. Extensive forests of ponderosa pine, Douglas-fir, aspen, and pinyon-juniper in contrast with colorful and deeply eroded rock formations make this one of the most spectacular landscapes in the United States.

U.S. Forest Service Resource Bulletin INT-4 1965

FORESTS IN UTAH

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Division of Forest Economics
and Recreation Research

Intermountain Forest and Range Experiment Station
Forest Service
U.S. Department of Agriculture
Ogden, Utah
Joseph F. Pechanec, Director

FOREWORD

Inventory data in this report are the result of the first comprehensive survey of Utah's timber resource. The survey was conducted as part of the continuing nationwide Forest Survey. Fieldwork started in 1956 and was completed in 1961. The Intermountain Region of the U. S. Forest Service inventoried National Forest lands, and the Intermountain Forest and Range Experiment Station inventoried lands outside National Forests. The Intermountain Station combined the two sets of data into the Statewide compilation on which this report is based. Statistics on timber cut and timber products output for 1962 were collected in 1963 by the Intermountain Station.

Although the Survey shows that Utah has 1.3 times the commercial forest area and 2.5 times the volume of live sawtimber that were reported for 1952 in "Timber Resources for America's Future," (U.S. Forest Serv. 1958),[1] actual changes in timber conditions are believed minor. The most recent figures are based on a statistically designed survey, whereas the previous estimates were not. Also, some of the differences in estimates result from changes in commercial forest area and tree measurement standards.

The appendix to this report should be consulted for definitions of terms, description of survey methods, reliability of estimates, detailed timber statistics, and a generalized timber type map.

[1] *Names and dates in parentheses refer to Literature Cited, p. 41.*

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STATISTICAL HIGHLIGHTS

FOREST AREA

- Utah's forested area is 14.9 million acres, or 28 percent of its land area.
- The commercial forest covers 4 million acres, or 27 percent of the forest land.
- 9.3 million acres are classed as pinyon-juniper type. This is 86 percent of the noncommercial forest and 18 percent of the land area of the State.
- 83 percent of the commercial forest is publicly owned. The U.S. Forest Service administers 70 percent of the total commercial forest.
- Two-thirds of the commercial forest is in sawtimber stands, and these stands average 6,904 board feet per acre.[2]
- Aspen and fir-spruce are the largest timber types in the commercial forest. They cover about one-third and one-fourth of the commercial area, respectively.

TIMBER VOLUME

- Commercial forests have 5.8 billion cubic feet in sound, live trees, and 19.5 billion board feet in sawtimber trees.
- About 90 percent of the timber volume is publicly owned.
- Engelmann spruce is the leading species in sawtimber inventory—comprising 5.8 billion board feet or 30 percent of the total in all species.

STAND CONDITIONS

- Most sawtimber stands and at least one-fourth of the poletimber stands are overmature. Seventy percent of the growth on sawtimber trees is offset by trees that die.
- Sawtimber mortality is more than three times the sawtimber cut.
- Insects and disease cause at least one-third of the mortality.

TIMBER USE

- In 1962 Utah's timber cut of 12.6 million cubic feet was one-fifth of 1 percent of its inventory. This is one-third the cutting rate for the Mountain States[3] as a whole.
- 90 percent of the roundwood products in 1962 was saw logs for lumber.
- Between 1960 and 1962 roundwood production decreased 19 percent and lumber production 3 percent.
- Between 1960 and 1962 the number of active sawmills dropped from 99 to 73, but average annual production per mill increased from 700,000 board feet to 918,000.
- Engelmann spruce was the leading lumber species in 1962 and accounted for about one-third of the lumber cut.
- Garfield County was the only county that had a saw log cut of more than 10 million board feet in 1962.

---

[2] *International $\frac{1}{4}$-inch log rule board-foot volumes are used throughout this report unless otherwise stated.*

[3] *The following are considered as Mountain States in this report: Montana, Idaho, Nevada, Utah, Wyoming, Colorado, New Mexico, and Arizona.*

THE FORESTS

Utah's forest lands—15 million acres of foothills, high mountains, and plateaus—comprise 28 percent of the land area of the State. These forested highlands, which provide contrast and scenic relief from the arid climate of the level expanses of the Great Basin to the west, and of the canyon country to the south and east, have long been highly important to Utah and the Nation. The water these highlands could furnish for irrigation, and the timber needed for dwellings and many other uses, were important reasons why the Mormon migrants chose Utah as their stopping place in 1847. Subsequently, uses of forest lands have expanded in number and intensity until now some of Utah's forests are as heavily used as any in the country. The variety of uses and the effect one has on another, make it necessary to go beyond a discussion of the timber situation—the principal concern of this report. Water, recreation, and forage uses of forest lands also will be discussed in terms of values, trends, and some of the problems related to multiple use management.

The forests lie mostly between 5,500 and 11,000 feet in elevation

On the average, the forests begin at 5,500 feet in elevation. They extend up to timberline of about 10,000 feet in the northern part of the State and 11,000 feet in th southern. However, local conditions of soil and climate cause substantial variations. For example, near Santa Clara in southwestern Utah, pinyon and juniper trees grow at elevations as low as 3,200 feet.

Within the forested zone, precipitation and other climatic influences greatly affect the distribution of species. The general increase in precipitation from low to high elevations is a principal factor in the zonation of vegetation. Most of the pinyon-juniper lands receive from 10 to 16 inches of water a year. Above the 16-inch precipitation zone the general progression of species is (1) mountain brush[1] and/or ponderosa pine, (2) aspen, Douglas-fir, white fir, lodgepole pine, (3) subalpine fir and Engelmann spruce (fir-spruce type) and, (4) whitebark, limber, and bristlecone pines. This zonation, however, is far from consistent. Wide local variations occur because of site factors (as shown by the photo on the next page), fires, logging, and other land uses.

Fire has greatly affected the distribution and extent of the forest area and of individual species. Many of the biggest fires that influenced or determined present forest patterns occurred before white men settled in Utah. As John Wesley Powell (1879) observed in his Utah explorations between 1868 and 1879, Indians habitually set fires to drive game. His description of the vast acreages burned at that time and earlier is supported by the present area and age of stands of aspen and lodgepole pine. These species, which are noted for ability to regenerate after fire or to invade burned-over lands, now cover 2.0 million acres. Age of the stands indicates a great many started growing before 1850. After the Mormon pioneers settled in Utah the annual burn declined. Intensified detection and suppression efforts in recent decades reduced the forest area burned in Utah from 21,000 acres annually in the period 1943-52 to about 16,000 acres annually in the decade 1953-62. One of the most important results of reduced annual burn has been more favorable conditions for pinyon-juniper.

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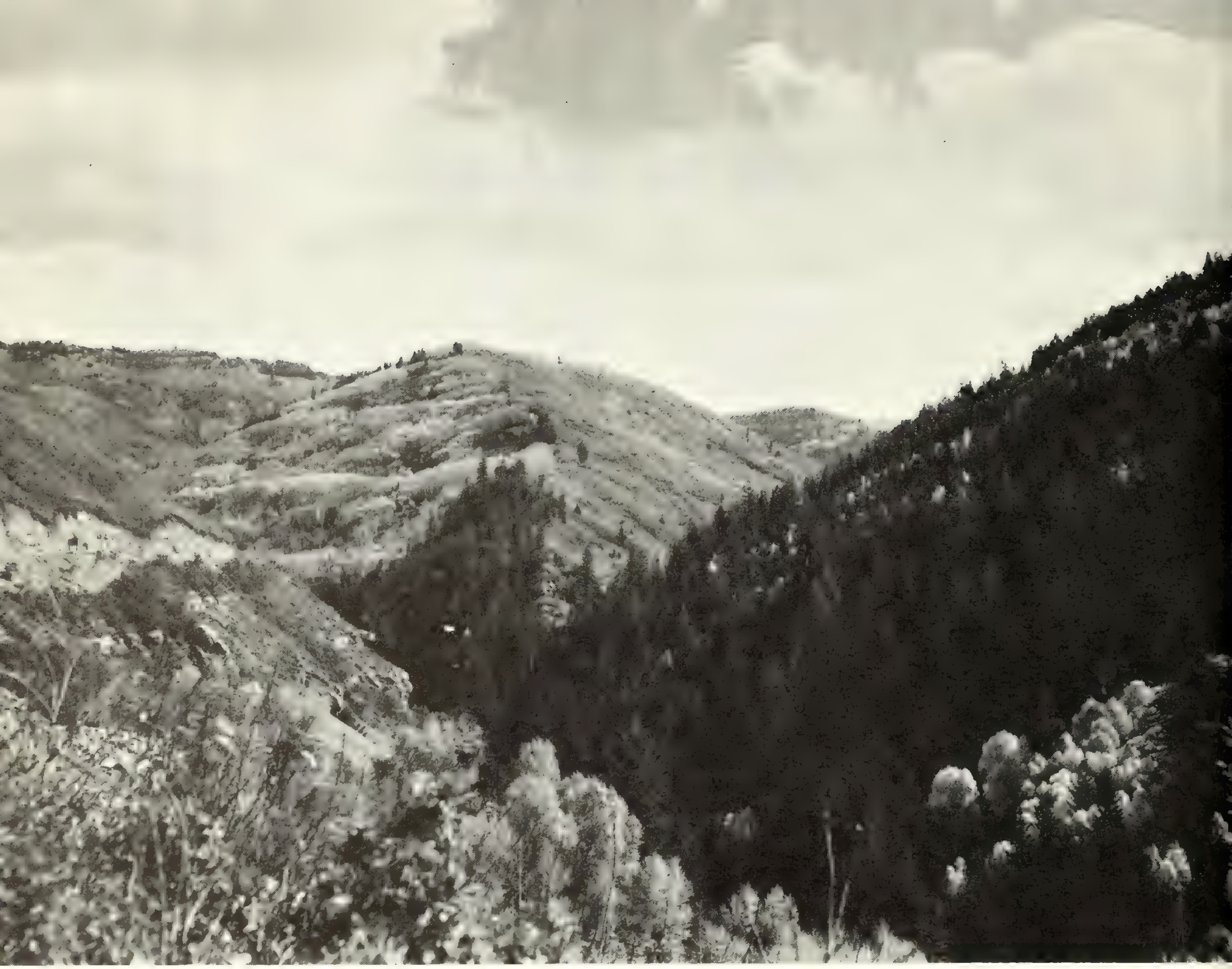
[1] *Mountain brushlands in Utah that are classified as forest consist largely of Gambel oak. However, other deciduous species are present in some areas, as well as broadleaf evergreens such as mountain mahogany. These lands are considered by Forest Survey as chaparral and are so designated in the statistical tables and generalized type map in the appendix to this report.*



About one-fourth of the forest area is commercially valuable for timber production

Four million acres, or 27 percent, of the forest area is classed as commercial.[5] The other 73 percent of the forest is classed as noncommercial and consists mainly of lands not suitable for commercial timber production. (Photo above and map on next page.) Only 165,000 acres of commercial quality forest in Utah are reserved from timber cutting and are therefore considered noncommercial. These lands lie in parks and wilderness area.

Commercial and noncommercial forest lands on the Manti-LaSal National Forest, east of Fairview. This photo, which was taken facing east, shows commercial forest of Douglas-fir and aspen on the north-facing slopes. Parts of the hotter and drier south-facing slopes have noncommercial forest of mountain brush.

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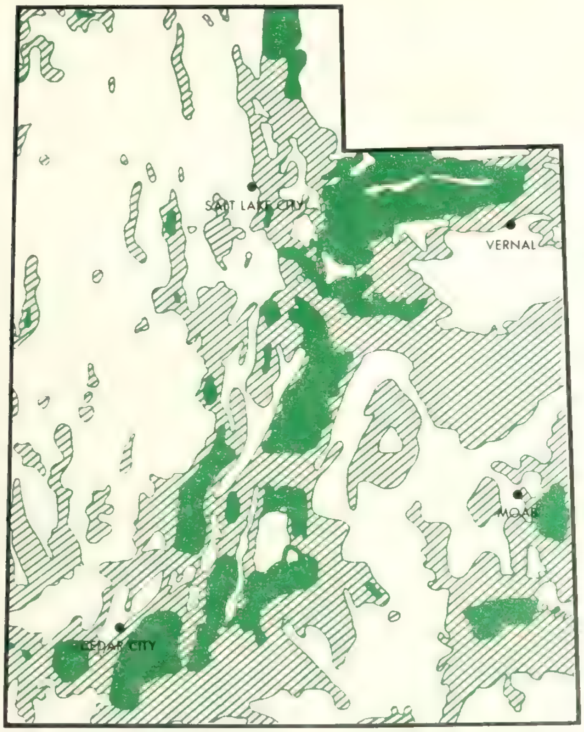
[5] *Forest land that is producing or is capable of producing crops of industrial wood and is not withdrawn from timber utilization.*



		million acres
🟩	commercial	4.0
▨	noncommercial	10.9
	total forest	14.9

The noncommercial forest is mainly pinyon-juniper

Utah has a lot of pinyon and juniper. The 9.3 million acres covered with these scrub conifers is almost 18 percent of the area of the State, and about 86 percent of the total noncommercial forest area. One million acres of mountain brush and about 0.6 million acres in aspen, fir-spruce, Douglas-fir, and other types make up the remainder of the noncommercial area.

Most of the noncommercial forest is at low and relatively dry elevations below the commercial forest zone and consists largely of pinyon-juniper and mountain brush. However, adverse climate and soil conditions at the upper forest elevation cause some of the timber to be noncommercial also. At intermediate elevations there are still other patches of noncommercial forest on poorer, shallower soils within the commercial zone.

Ownership of the 10.9 million acres of noncommercial forest is largely (about 80 percent) public. Roughly, 50 percent of the total noncommercial forest is administered by the Bureau of Land Management.

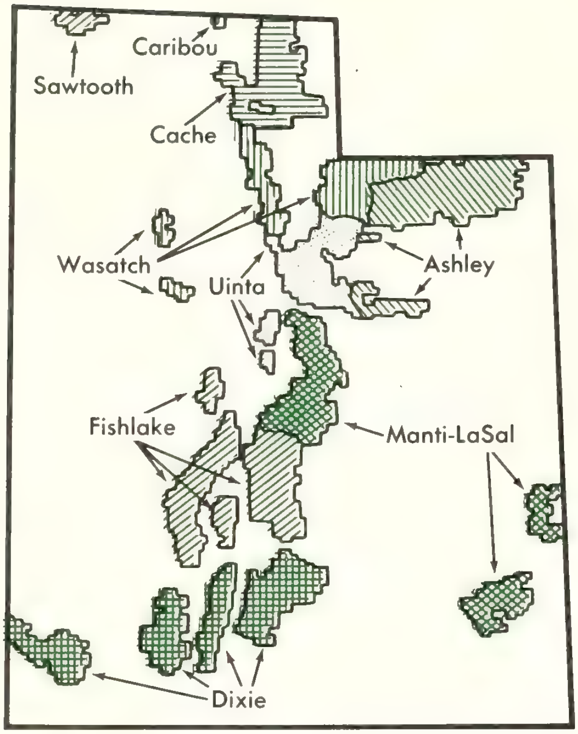
Pinyon-juniper lands are important in a number of ways. These dwarf trees form the predominant vegetative type on a substantial percentage of Utah's rangeland. Many thousands of acres of pinyon-juniper land have had sufficient potential for forage and cropland to justify clearing by public agencies and private owners. Use of the estimated 1,573 million cubic feet of wood in the two species (pinyon 48 percent, juniper 52 percent) has been minor. Fenceposts, fuelwood, charcoal, and Christmas trees are the principal products. The Bureau of Land Management (in cooperation with Utah State Experiment Station, Utah State University) is sponsoring research that may lead to greater use of pinyon-juniper lands.

The commercial forest is largely on public lands

About 83 percent of the commercial forest area and approximately 90 percent of the timber volume are in public ownership—mainly as National Forest. The distribution among ownerships is as follows:

	Thousand acres	*Million cubic feet*	*Million board feet*
National Forest	2,783	4,635	15,951
Bureau of Land Management	155	166	579
Indian	158	165	545
State	240	237	719
Farmer	540	500	1,354
Miscellaneous private	123	122	373
Total	3,999	5,825	19,521

NATIONAL FORESTS



National Forests in Utah form a broken band running down the center of the State (map above). They lie on the Wasatch Mountains at the north end and follow high plateaus — Wasatch, Markagunt, Paunsaugunt, Aquarius, and others—to the south. Other principal areas are the arm to the east along the Uinta Mountains, and isolated patches on the LaSal and Abajo Mountains in the southeast.

The lands that are now in nine National Forests were removed from the public domain between 1897 and 1908 as areas of particular importance for preservation of watershed and timber values. The Uinta was the first National Forest in the State, and one of the first in the United States.

Commercial forest lands administered by the Bureau of Land Management, or in State or private ownership, are generally in small and scattered parcels. Many of these tracts border or lie within the National Forests, although some occur on isolated highlands within the Great Basin or Colorado Plateau.

Holdings are less dispersed in the Indian and National Forest lands. Indian lands are largely within the Uinta-Ouray and Navajo Reservations. (Only 13 percent of all lands within National Forest boundaries is not in National Forest ownership.)

Sawtimber stands predominate in the commercial forest

About 66 percent of the commercial forest area is in sawtimber stands. Only 28 percent is poletimber, 5 percent saplings and seedlings, and 1 percent nonstocked.

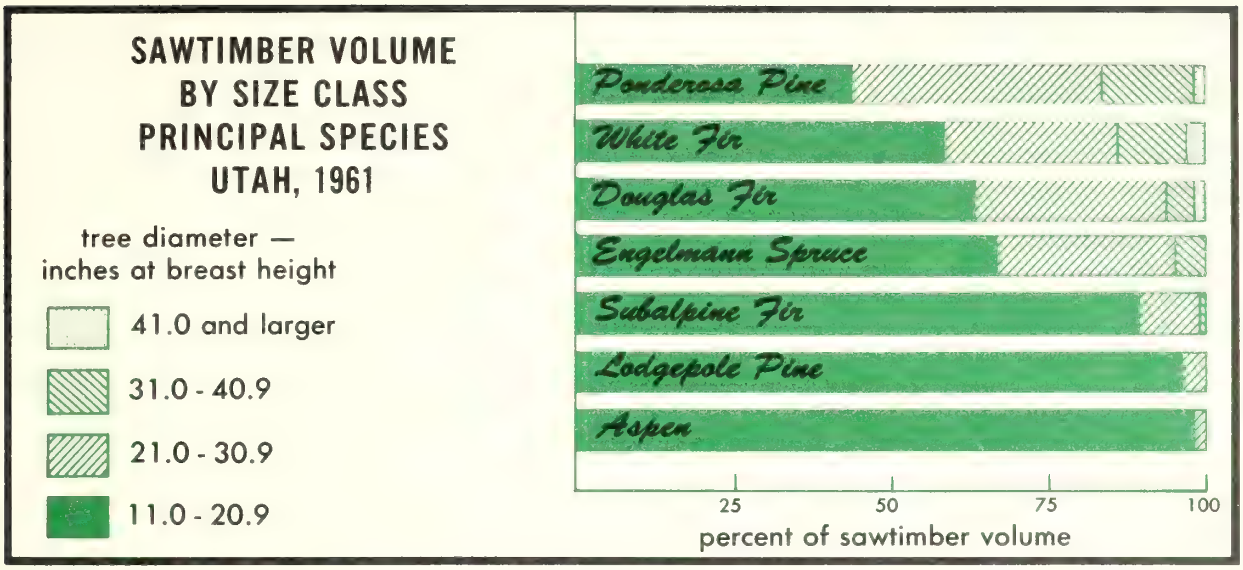
	Thousand acres
Large sawtimber[1]	**572**
Small sawtimber	**2,057**
Total sawtimber	**2,629**
Poletimber	**1,125**
Sapling and seedling	**218**
Nonstocked	**27**
Total all classes	**3,999**

[1] *Stands in which most of the board-foot volume is in trees 21.0 inches d.b.h. and larger.*

The figures above are for all commercial forest land, but the proportions are about the same for each of the principal classes of owners.

Of the 2.6 million acres of sawtimber stands in the State, only 22 percent is classed as large sawtimber. This compares with about 36 percent for the entire Rocky Mountain area. Twenty-eight percent of Utah's 19.5 million board feet of sawtimber is in large sawtimber trees.

Sawtimber stands in Utah have an average volume of 6,904 board feet per acre. In comparison, the average for Idaho is 12,560, Montana 9,661, and Colorado 7,317.



Average diameter of sawtimber trees varies greatly among species. Ponderosa pine has a greater percentage of sawtimber volume in larger diameter classes than any other species (chart above).

Height must also be considered in comparing tree sizes. Engelmann spruce sawtimber trees have a greater average total height than those of other species — although a height of more than 100 feet is not common for this species. White fir and Douglas-fir have relatively few trees over 90 feet high, while not many ponderosa pine are taller than 80 feet—except on parts of the Dixie National Forest.

Tree height in relation to age is the criterion used as the measure of site quality (site index[6]) in the table on this page. A close and reliable comparison of site quality in Utah with that of other Mountain States will not be possible until more data are available from some of the other States. Perhaps the best indication of productivity is yields of sawtimber stands. According to that criterion Utah is considerably below average. The photo on the following page shows the change in site quality that frequently occurs within a short distance on Utah's steep slopes.

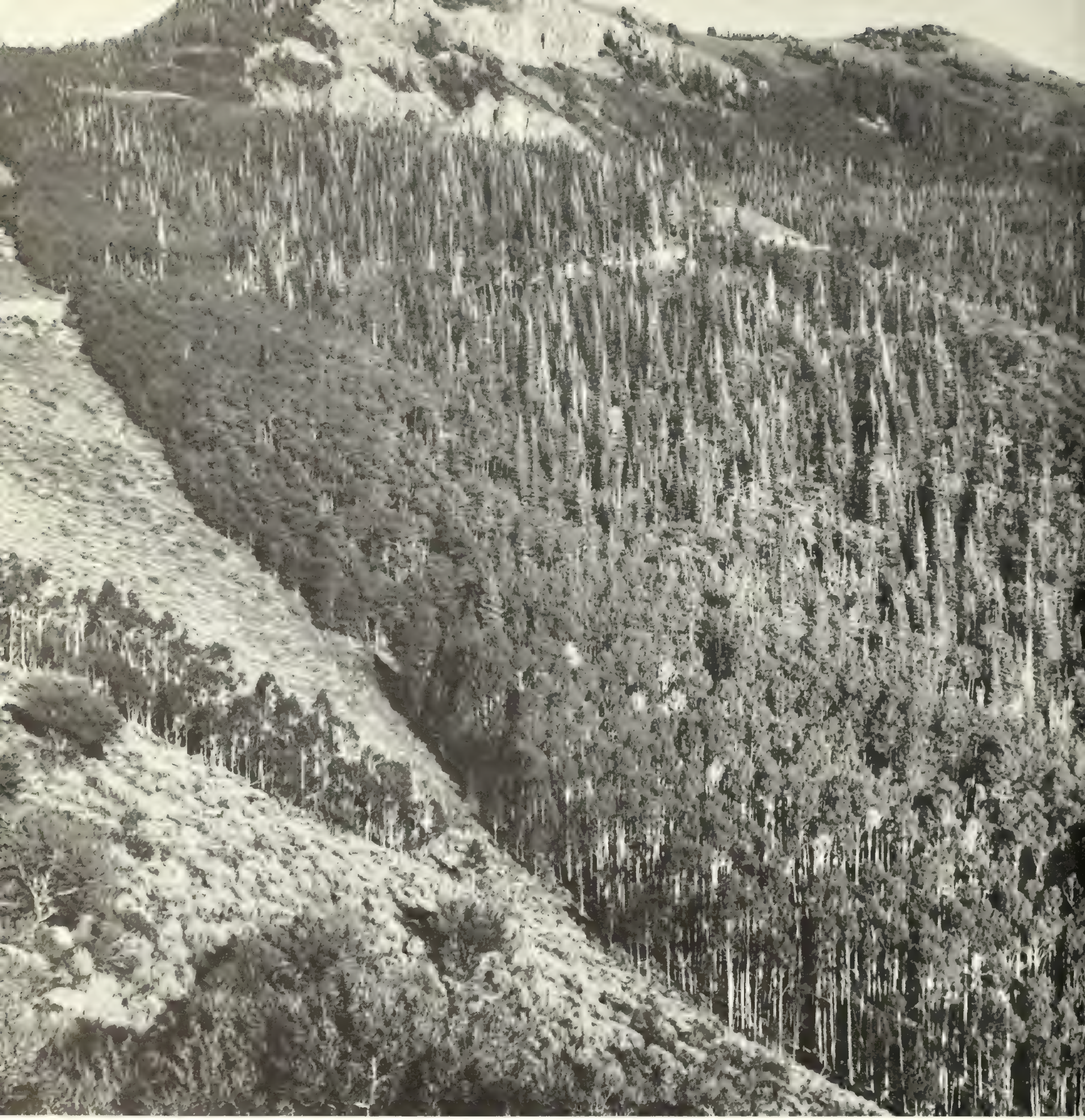
---

[6] *Site index is the height in feet of average dominant and codominant trees at a specified age (100 years for ponderosa and lodgepole pines, 50 years for other species). For example, "site index 70" for ponderosa pine means the dominant and codominant trees on the area referred to average, have averaged, or will average 70 feet in 100 years.*

PERCENT OF AREA OF PRINCIPAL TIMBER TYPES BY SITE INDEX CLASSES

Type	Site index class										Average site index
	20	30	40	50	60	70	80	90	100	110	
Fir spruce[1]	4	28	33	25	8	2					40
Douglas-fir	3	21	39	24	9	4					43
Ponderosa pine			22	9	43	10	14	2			59
Lodgepole pine			30	41	18	8	2	1			51
Aspen	12	37	33	12	4	2					36

[1] *Based on site index for Engelmann spruce*



This aspen stand (along the edge of the nonforested area) illustrates how site quality for a species can change from good to poor within a very short distance on Utah's steep slopes. Trees at the bottom and top of the slope are the same age. However, those growing under the favorable soil and moisture conditions of the lower slopes are of sawtimber size and nearly 100 feet tall while those on the dry thin soils of the upper slopes are scrubby saplings. This stand covers an elevational range of about 1,000 feet on the west slopes of Monroe Peak, Fishlake National Forest.

Most stands are old; insect and disease losses are high

Although precise figures on age of stands are lacking, rough estimates can be made. About 70 percent of the coniferous sawtimber stands are more than 100 years old. More than 85 percent of the aspen sawtimber stands are more than 80 years old and can therefore be considered overmature. Many lodgepole pine stands of poletimber size are also mature. Trees in these old stands are growing very slowly and many are dying. While sawtimber trees make a total annual growth of about 321 million board feet, trees that die reduce this gain by about 70 percent.

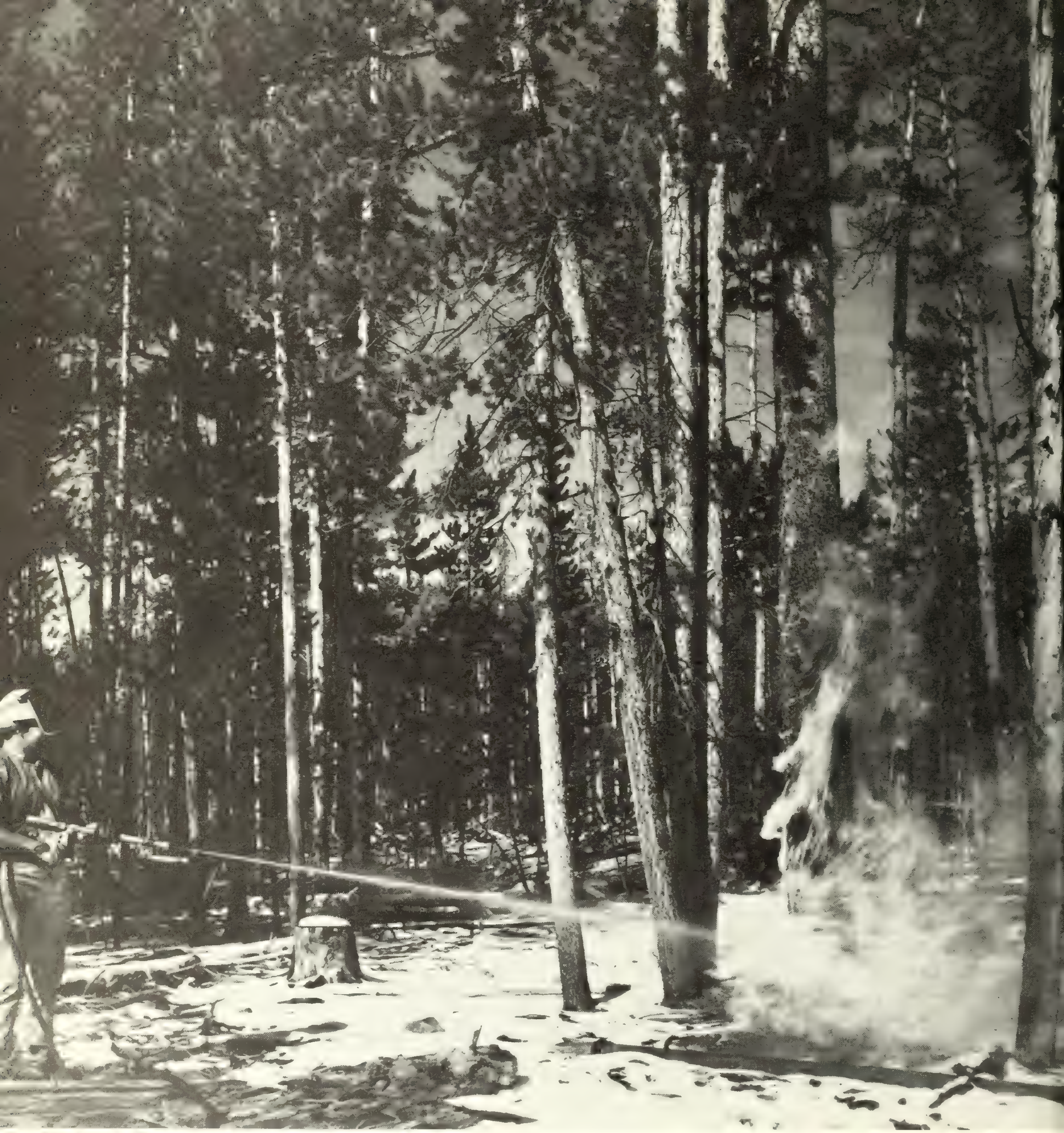
Old stands are especially susceptible to disease and to attack by certain species of insects. The primary effect of most diseases is a reduction in growth rates, rather than a rapid killing of trees. On the other hand, insects—especially bark beetles—frequently kill trees very rapidly in old growth stands. For example, heavy attacks by Engelmann spruce and mountain pine beetles mean that infested trees will die within a year or two.

Among the many insects prevalent in Utah's forests, bark beetles have done the most damage in recent years and have been the most expensive to control. The mountain pine beetle has been particularly troublesome —especially in lodgepole pine stands, and to a lesser extent in ponderosa pine. Control measures have greatly reduced populations within the major epidemic areas on the north slope of the Uinta Mountains (photo on next page).

Many areas have infestations of other bark beetles — Engelmann spruce beetle, Douglas-fir beetle, fir engraver beetle, and Black Hills beetle. Although epidemic populations of these beetles develop periodically, they are not now at high levels. Defoliating insects are also widespread—in epidemic proportions in some areas. They chiefly cause loss of growth rather than death of trees, but several species are known to be tree killers.

Diseases and decay, while usually less dramatic in their effects than insects, nevertheless take as big if not a bigger toll from Utah's forests. Dwarfmistletoe is one of the worst enemies of the forest. This parasite is particularly common on lodgepole pine and Douglas-fir, but also thrives on ponderosa pine, especially in southern Utah. Although there are no data to show the total effect of dwarfmistletoe on timber growth and volume in Utah, some idea may be gained from local studies. About 55 percent of an area of 283,000 acres of lodgepole pine on the north slope of the Uinta Mountains has a significant amount of infection. Surveys in lodgepole pine stands in similar areas in Wyoming and Colorado showed that gross merchantable volumes in virgin stands free of dwarfmistletoe were 1.5 times as large as those in infected stands (Hawksworth 1958). These surveys also showed that dwarfmistletoe is especially prevalent in cutover stands such as those which were partially cut for railroad ties many years ago. Many such areas are included in the 216,000 acres of poorly stocked stands, and 226,000 acres of medium-stocked stands of lodgepole pine in Utah.

Many important diseases attack other species. Cull and growth loss caused by broom rusts are important in the fir-spruce type. Several native rusts of ponderosa and lodgepole pine deform many trees and cause cull, growth reduction, and mortality. In aspen, cankers are a major chronic affliction, and foliage diseases are periodically widespread.



Mountain pine beetle control in lodgepole pine stands on the Wasatch National Forest. This insect has ravaged extensive areas on the north slope of the Uinta Mountains. Here, during the years 1958 to 1963, more than 500,000 infested lodgepole pine trees were treated on an area of roughly 165,000 acres straddling the Utah-Wyoming border. Many of these trees were treated with toxic chemicals, some standing trees were burned (as in the photo above), some trees were felled and burned, and others were logged. Beetle populations in this particular area of infestation have been reduced to a relatively low level.

Five timber types make up almost the entire commercial area

Five timber types — fir-spruce, ponderosa pine, Douglas-fir, lodgepole pine, and aspen — comprise more than 99 percent of the commercial forest area. The distribution of area among these types is shown in the table below. Volumes of the seven principal species that occur in these types are as follows:

	Sound live trees[1]	**Sawtimber trees**
	Billion cubic feet	*Billion board feet*
Aspen	1.3	2.1
Engelmann spruce	1.2	5.8
Lodgepole pine	1.0	2.5
Douglas-fir	.9	3.9
Subalpine fir	.6	1.7
Ponderosa pine	.4	1.9
White fir	.3	1.3

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[1] *Sawtimber and poletimber trees.*

In addition to the five types listed above, which are illustrated and described on pages 10 to 19, there are two minor types—whitebark-limber-bristlecone pine, and cottonwood.

Whitebark, limber, and bristlecone pines are high-elevation species often intermingled with Engelmann spruce, subalpine fir, and Douglas-fir. Because they grow on thin soils and in exposed locations most of the trees of these species are noncommercial. However, the whitebark, limber, and bristlecone pines on 29,000 acres are of sufficiently good quality to be classified as a commercial timber type. Most of the 221 million board feet of sawtimber in these species is limber pine. Very little is being harvested.

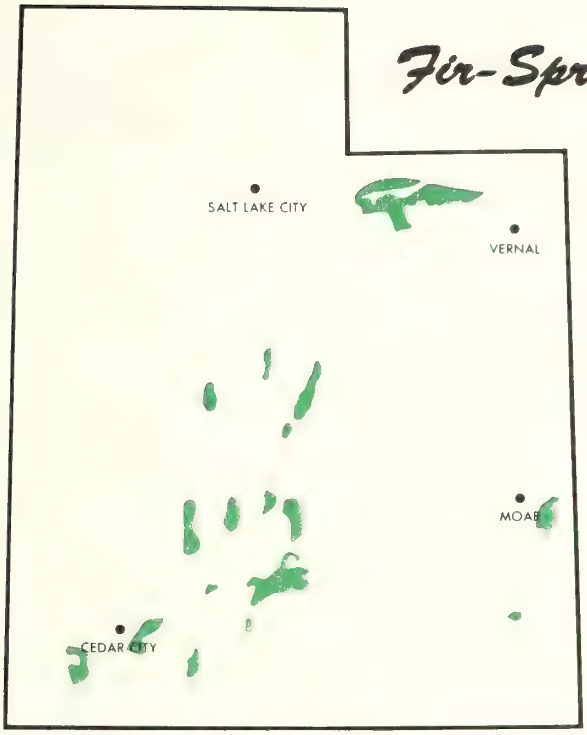
Far more cottonwood grows in Utah than is shown by Forest Survey estimates of 2,000 acres of cottonwood type and 2.3 million cubic feet of wood. Probably several times this amount is in clumps and stringers along streams; such areas are too narrow to qualify as forest by Forest Survey standards, and are classed as nonforest or are included in other forest types. Because cottonwood grows at lower elevations than other species suitable for lumber, it was important as a timber species to the early settlers. Substantial amounts have been cut annually throughout the years and in 1960 and 1962 cottonwood lumber production was 1.3 and 0.6 million board feet, respectively.

COMMERCIAL AREA OF PRINCIPAL TIMBER TYPES BY STAND-SIZE CLASS

	All stands	Sawtimber	Poletimber	Sapling-seedling	Nonstocked stands
			Thousand acres		
Aspen	1,280	386	753	124	17
Fir-spruce[1]	1,047	947	77	22	1
Douglas-fir	646	556	56	33	1
Lodgepole pine	563	311	223	28	1
Ponderosa pine	432	403	14	8	7

[1] *Included in the fir-spruce type is an area of 192,000 acres that is predominantly white fir. White fir is not recognized by Forest Survey as a major independent type.*

Fir-Spruce Forests



The stand of Engelmann spruce shown on the facing page is growing at an elevation of about 10,000 feet on the Fishlake National Forest. Larger trees are mature, more than 21 inches in diameter, and more than 110 feet in height.

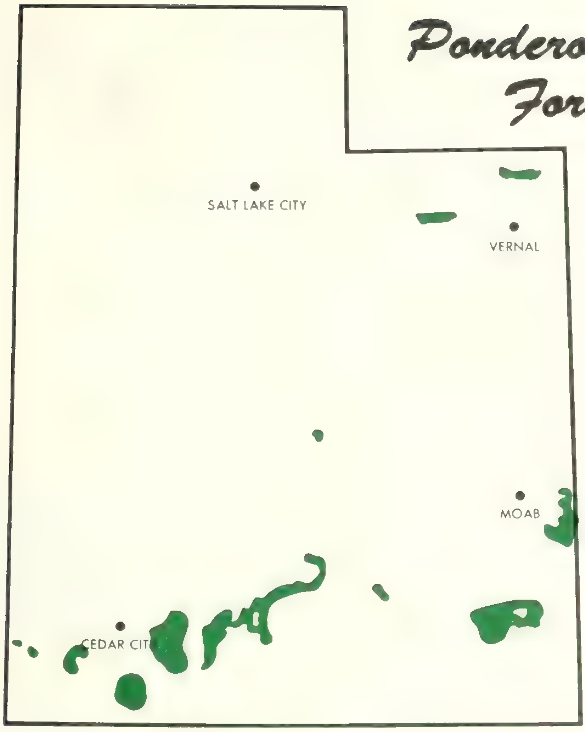
The fir-spruce type occupies about 26 percent of the commercial forest area in Utah; in area covered, it is second only to aspen. The type occurs in many areas in the State, but always at high elevations—usually just below timberline, although it extends to lower elevations in sheltered locations. Engelmann spruce or subalpine fir predominate, either singly or in combination, in areas classified as fir-spruce type; Douglas-fir, white fir, and lodgepole pine are common associates. Ninety percent of the type is in sawtimber stands; about one-half of these stands are overmature. The 5.8 billion board feet of spruce in Utah is 30 percent of the State's sawtimber inventory. Subalpine fir and white fir comprise 9 and 7 percent, respectively, of the sawtimber in Utah.

Slightly more than one-fourth of all lumber produced in Utah since 1869 has been Engelmann spruce. Starting in 1959, spruce became the leading species for lumber and in 1962 accounted for about one-third of the State's lumber production.

True firs[7] have generally accounted for only about 6 percent of the State's annual lumber production. However, in 1962 about 15 percent, or almost 10 million board feet, was from true firs; probably much more than 50 percent of this was white fir.

[7] *Subalpine fir and white fir are reported together as true firs in estimates of lumber and saw log production.*

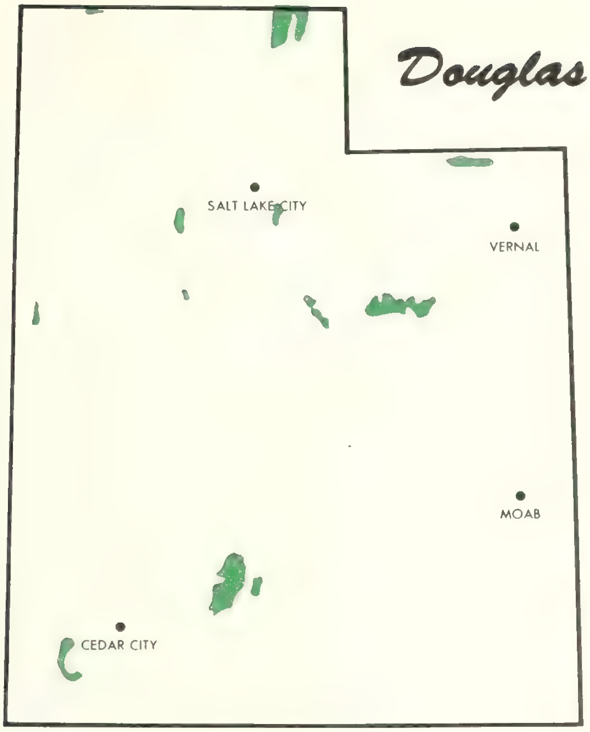
Ponderosa Pine Forests



The photo facing this page shows a stand of ponderosa pine of large sawtimber size on the Markagunt Plateau, Dixie National Forest. Trees in the foreground are about 26 inches in diameter, 90 feet high, and 180 years old.

About 432,000 acres, or 11 percent, of the commercial forest in Utah is ponderosa pine. The greatest proportion of the type is in the southern part of the State—53 percent is on the Dixie National Forest, and 14 percent on the Manti-LaSal (principally on the LaSal Division, which lies near the Colorado border). Ponderosa pine generally grows at lower elevations than any other commercial species, and in many areas oak and herbaceous vegetation are abundant in the type. Although 93 percent of the type area is sawtimber, a smaller percentage of the trees are overmature than is the case in other types. This reflects the relatively heavy use of ponderosa pine for many years.

About 41 percent of all lumber sawed in Utah since 1869 has been ponderosa pine, and between 1869 and 1904 this species accounted for about 90 percent of the cut. In 1962, ponderosa pine made up about one-fifth of the sawtimber cut. Ponderosa pine continues to be the leading species harvested annually in terms of the percentage of inventory of individual species (see chart page 32) because it is a large tree, has good wood properties, and is easily accessible for logging.



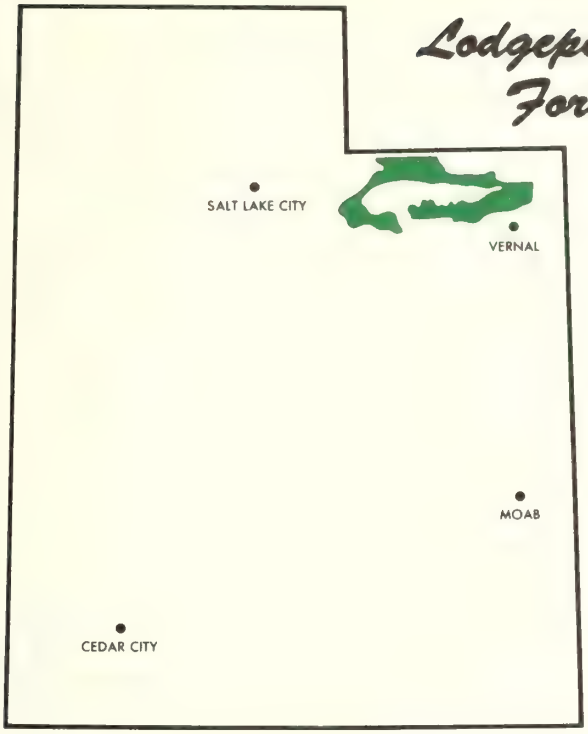
Douglas Fir Forests

A stand of Douglas-fir poles and small sawtimber (photo on facing page) in Logan Canyon, Cache National Forest. These trees are growing in a draw on a north-facing slope. This is a more favorable site than the steep and exposed slopes with thin soils characteristic of Douglas-fir sites in Utah. Under the latter conditions trees are more widely spaced, shorter, and of poorer form than those seen in this photo. For this reason Douglas-fir timber value is usually low, but watershed protection value is high.

The Douglas-fir type covers 646,000 acres, or 16 percent of the commercial forest. The type is widely distributed geoprahically and grows at intermediate elevations—above ponderosa pine and mountain brush but below the principal areas of fir-spruce. Trees of most of the other commercial species are also often present in the type. Eighty-six percent of the area of Douglas-fir type is in sawtimber stands, and between 40 and 50 percent of these are overmature. Compared to most other types, a relatively high proportion (22 percent) is in private ownership. The 3.9 billion board feet of Douglas-fir sawtimber in Utah comprises 20 percent of the State's sawtimber inventory.

The cut of Douglas-fir has generally been small compared to that of the other principal species in Utah's forests. Since 1869 only 8.5 percent of the lumber sawed in the State has been Douglas-fir. In 1962 it was only about 10 percent.

Lodgepole Pine Forests

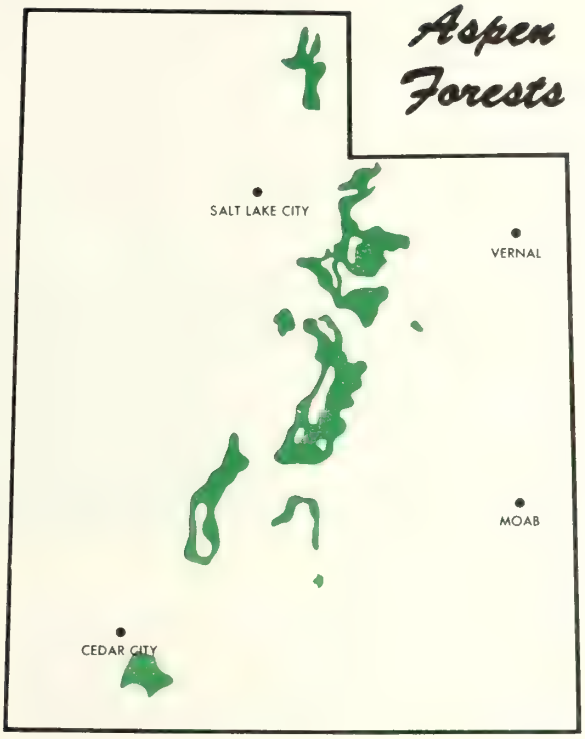


The photo to the left shows a lodgepole pine stand of small sawtimber trees on the Wasatch National Forest. This stand on the north slope of the Uinta Mountains has features of many of the old stands in this area. It was logged for railroad ties in the 1800's and only trees that would meet specifications for tie timber were cut; trees that were too large or too small were left. Opening the stand favored development of dwarfmistletoe which is now extremely widespread and has a big effect in reducing tree growth. "Brooms," such as appear on many of the trees shown in the photo, are one indication of the presence of dwarfmistletoe. Presence of this parasite is only one of the several problems involved in managing lodgepole pine, discussed later in this report.

The lodgepole pine type grows mainly on the Uinta Mountains in the northeast portion of the State. Of the 563,000 acres of commercial lodgepole area in Utah, 83 percent is in National Forest ownership within the Wasatch and Ashley Forests. Much of the remainder is also within the boundaries of these Forests but is in private and other public ownership. The type covers a considerable range of intermediate elevations—in some places from the upper limit of the pinyon-juniper area up to almost timberline. More than 50 percent of the lodgepole pine area has stands that are beyond rotation age. These old stands are largely of sawtimber size. However, because lodgepole pine tends to grow in stands that are so crowded that growth is badly inhibited (often to the point of stagnation of the stand), many trees reach maturity before graduating from pole-timber size.

Lodgepole pine has averaged only about 15 percent of the annual lumber production in recent years as well as throughout the period since 1869. However, large volumes of nonlumber products have been cut from lodgepole pine stands. Millions of railroad ties were hand hewn from this species during the "tie-hack" era of the late 1800's and early 1900's. Most of these were cut on the north slope of the Uintas and floated down to concentration yards in Wyoming. Round mine timbers, poles, and posts were also cut in great numbers from lodgepole pine for many years. Lumber, including sawed mine timber and ties, has gradually increased as a proportion of the cut, and now roundwood products make up only 5 percent of the output of all lodgepole pine products.

Aspen Forests



Aspen sawtimber on the Fishlake National Forest (photo on facing page). This mature stand is at an elevation of almost 10,000 feet. The larger trees shown here are about 18 inches in diameter and 80 feet high.

Utah shares with Colorado the distinction of having some of the finest aspen in North America. Within recent years several aspen trees in Utah have been acclaimed the largest (in diameter) in North America. The latest is a tree 42 inches in diameter at the foot of Mt. Nebo (Cottam 1963).

The aspen type covers more acres in Utah than any other commercial type — 1.3 million acres, or 32 percent of the commercial forest. It grows throughout the elevational range of commercial forest and under a wider range of site conditions than any other species. As a result, many acres of unthrifty stands are on poor sites. On the other hand, Utah has extensive areas of thrifty, well-formed aspen trees, especially at mid-elevations in the central part of the State. Many aspen stands have a substantial understory of conifers which will eventually replace the aspen. Extensive areas, however, do not have such an understory and will continue indefinitely as aspen stands by reproducing through sprouts.

About 30 percent of the aspen stands are sawtimber size and 59 percent are poletimber size. The latter comprise two-thirds of the stands of poletimber size in the State. The aspen sawtimber volume of 2.1 billion board feet is about 11 percent of all the sawtimber in the State. Nearly seven-eighths of the sawtimber stands are overmature.

Aspen wood has properties that are desirable for many industrial purposes, but its use has been very minor in Utah. The wood is soft but tough, straight-grained, uniform in texture, tasteless and odorless, easy to work, relatively low in shrinkage, and shock resistant for a light wood. In Utah, aspen has been used principally for lumber, excelsior, houselogs, and core stock. Elsewhere, other important uses for aspen are for pulpwood, dimension stock, containers, and matchsplint veneer. Despite the potentialities for use, only 2.1 million board feet were sawed into lumber and 382,000 cubic feet used for excelsior and farm timbers in 1962. The timber cut for these products was only one-twentieth of 1 percent of the inventory of aspen—by far the lowest percentage of any of the major species.

The aspen forest, however, is very important for uses other than timber. It provides extremely valuable watershed protection. Aspen is an important browse species for big game and livestock, and in many areas the undergrowth in aspen stands provides some of the State's best wild land forage. And scenic value must be mentioned in any discussion of the importance of aspen. The brilliant autumn foliage of aspen stands in the American Fork and other canyons along the heavily populated Wasatch Front and elsewhere probably does as much to bring the forest to the attention of the average citizen as any of its economic values.

THE FOREST IN USE

The nearly 15 million acres of forest land in Utah have many values to the State and the Nation. Practically all these lands are very important for the water they provide the otherwise arid lowlands. A large proportion of these same acres also provides forage for livestock and big game, and nearly every acre provides habitat for other species of wildlife. Trees have been cut and used from many of the 4 million acres of commercial timberland. And practically the entire forest area is available to the public for recreation in some form—hunting, camping, and so forth.

The forests have been important for water, forage, and timber supplies since pioneer days. Substantial recreation use is a later development. Some forest uses have developed to the maximum that the land will support in its present condition. Many areas have been overused, and problems have resulted when attempts were made to restore these lands or least prevent further deterioration. On the other hand, large areas remain untapped for some values.

The next few sections discuss in a general way forest values and trends in their use.

Forests mean water

The water that runs off Utah's forests and other lands within the elevational range of the forests is an important source of supply in the Western States. It is by far the principal water supply for irrigation, domestic, and other uses in Utah's valleys and flatlands. It is also essential to downstream States, particularly Arizona and southern California.

Forests and intermingled open lands within the forested zone of Utah's mountains and foothills comprise about 49 percent of the land area of the State, but they furnish 78 percent of the State's water runoff.[8] The remaining 22 percent comes from the nonforest lands below or above the forest.

About 8.6 million acre-feet of water runs off all lands in the State each year. It flows in three drainages—Great Basin (56 percent), Colorado River (43 percent), and Columbia River (1 percent). The 78 percent of the State's total runoff that is contributed by lands in the forest zone is distributed among drainages in about the same proportion as the runoff from all lands in the State.

The total annual runoff of 8.6 million acre-feet represents an average of 1.9 inches over the entire State. However, as shown in the the following tabulation, there are substantial differences in the yield of water from nonforest and forest areas, and from different types of forest areas.

	Runoff Inches
Nonforest	0.8
Pinyon-juniper	1.0
Other forest	7.8
All lands	1.9

The generalized maps on pages 22 and 23 indicate the distribution of the classes listed above, principal water-yielding areas in terms of inches of runoff, and the major drainages.

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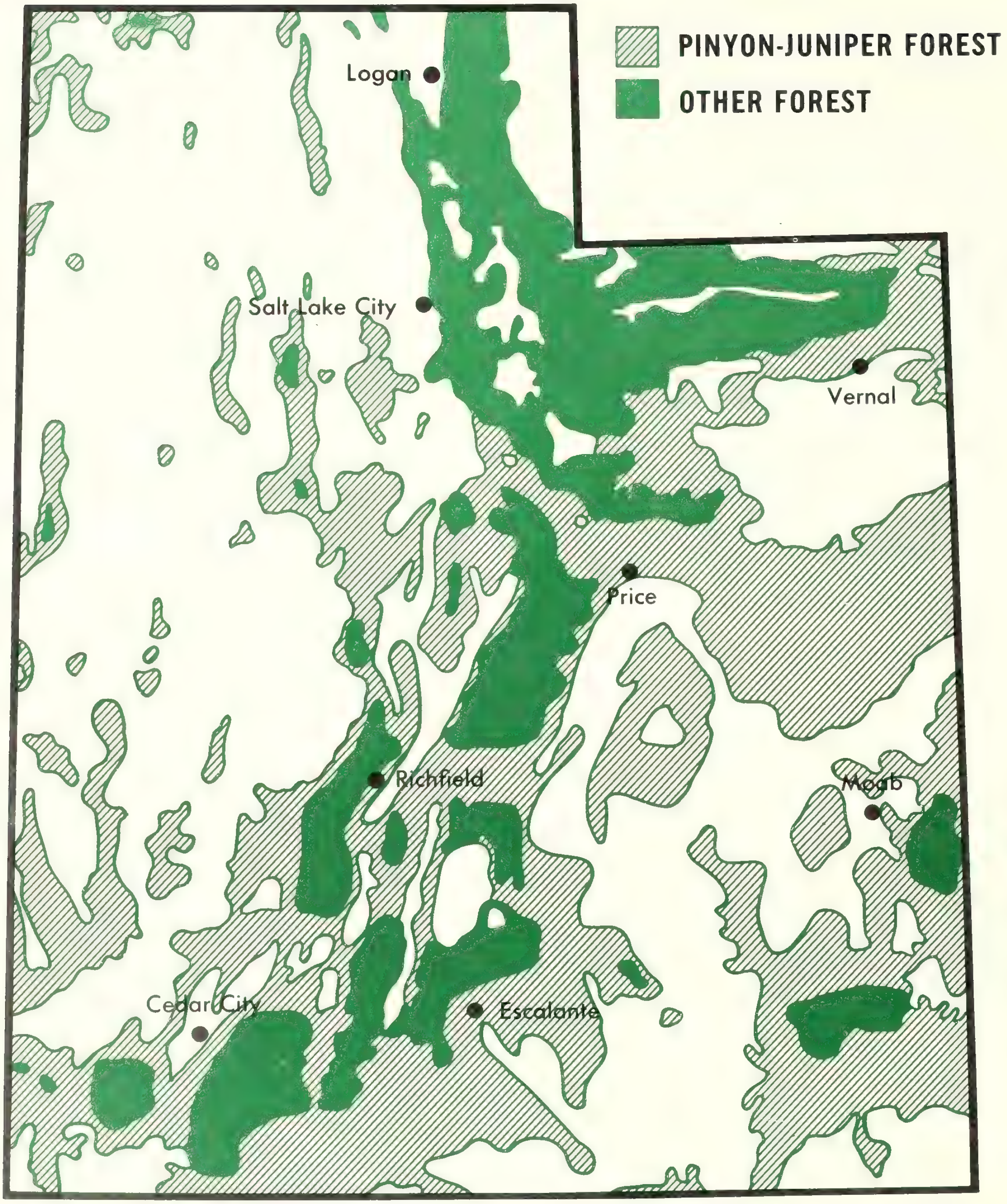
[8] *Estimates of water yield from forest lands (and other lands within the elevational range of the forests) are based on two sources of information: (1) the map* Major Timber Types *in the appendix of this report, and (2) the map* Mean Annual Runoff *in the report* Developing a State Water Plan, *Utah State University and Utah Water and Power Board, 1963. The maps were brought to a common scale and one superimposed on the other to determine relationships.*

This photo shows a panorama of multiple use opportunities at the south end of the Wasatch Plateau. This area, between 9,000 and 10,000 feet in elevation on the Manti-LaSal National Forest, is representative of many areas in Utah. These forests are of primary importance for protecting soil and other watershed values. This predominantly forested area, with its meadows, lakes, and streams, provides fir and spruce timber, forage for wildlife and livestock, water for many uses, and recreational values such as hunting, fishing, and scenery. Much of the forest and interspersed nonforest land in southern Utah presents outstanding opportunities for full and immediate multiple use management.

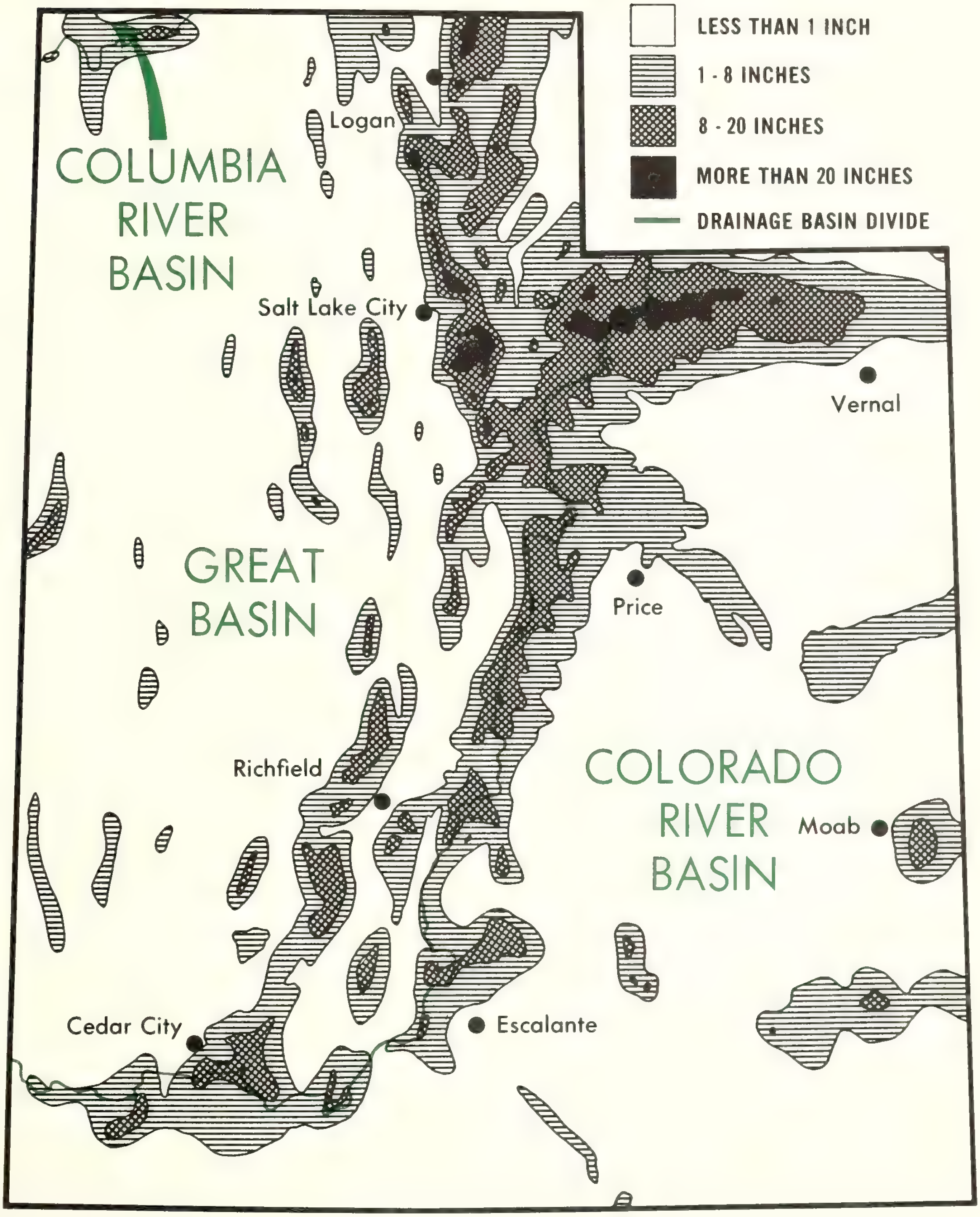
Water originating from the remains of the snowpack on the headwaters of Ephraim Creek at an elevation of about 9,500 feet. These waters will eventually be used in the Great Basin for irrigation, domestic needs, and other purposes. Almost four-fifths of the Great Basin's water runoff originates from mountain lands within the forested zones.

FOREST LANDS



Adapted from map "Major Forest Types, Utah, 1964" in appendix of this report.

MEAN ANNUAL RUNOFF AND PRINCIPAL DRAINAGE BASINS



Adapted from map "Mean Annual Run-off" shown in the report "Developing a State Water Plan," Utah State University and Utah Water and Power Board, 1963.

The value of forest and high elevation rangelands for water production is underscored by the importance of the water itself. Runoff, together with ground water supplies, represents the total available water for irrigation, municipalities, industries, livestock, recreation, fisheries, waterfowl, and other wildlife. The State's water requirements are expected to increase about 21 percent by 1980 (Utah State University and Utah Water and Power Board 1963).

The importance of Utah's mountains for water clearly indicates the vital need for watershed protection and other management. To date, projects on public lands have attempted mainly to restore impaired watersheds and to maintain soil stability on watersheds which are still in good condition. However, the expected increase in demands for water point to the need for increasing the quantity and quality of yields by forest management measures.

For many years the U.S. Forest Service has conducted research in Colorado and Utah into techniques for improving and increasing water supplies from forest lands in the Rocky Mountains. Studies in Colorado indicate that yields of water from the mountain snowpack and timing of the runoff vary significantly with the kind of forest (hardwood or softwood), size of trees, stocking of stands, degrees of thinning, harvesting patterns, and other factors. Evidence strongly indicates that yields of usable water can be increased by manipulating tree cover. However, much more research is needed before conversion from one type of tree cover to another can be considered economically practical. As part of this research the effects of such conversion on other forest values must be studied.

The forest range has a history of heavy and sustained use

Utah's forest ranges have been grazed for a long time. Pinyon-juniper, aspen, ponderosa pine, and other forested lands provided forage for deer, elk, antelope, and buffalo long before 1847 when Mormon pioneers drove in their herds of gaunt cattle. Livestock numbers were not long in building up. By 1880 at least 136,000 head of cattle and almost 600,000 head of sheep grazed on Utah ranges. Still greater increases in the boom period following 1880 resulted in statewide populations of 344,000 cattle and 3,818,000 sheep by 1900.

National Forest figures showing animals under permit provide a basis for indicating trends in use of the forest range since 1900. These data indicate the number of sheep on National Forests dropped from a peak of 1,001,000 in 1913 to 407,000 in 1962—a decrease of 59 percent. Cattle numbers were at their peak during World War I because of pressures for meat production. From a peak of 179,000 head of cattle on the National Forests in 1918, there was a drop of more than 40 percent to a level of 102,000 in 1962.

The largely uncontrolled grazing in early days left its mark on the range. As early as 1900 large areas of pinyon-juniper, aspen, ponderosa pine, and other forest rangelands were badly depleted of forage; even worse, soil cover was destroyed and the lands laid open for erosion. Depleted ranges, realization of the need for grazing controls, and economic difficulties in the sheep industry all contributed to the decline in number of livestock on the forest range.

Management of the range is complicated by the need for considering water, recreation, and wildlife values on practically the entire forest range. Competition for forage by deer and livestock has been a problem for many years, especially with the buildup of the deer population since 1930. However, competition is less acute in the mountain forest range than in the foothills because the amount of forage on the former is usually more plentiful. The foothill range, which generally is less productive and more limited in area than the summer range, is used more heavily—by deer in the winter and by livestock in the spring and fall seasons.

Many improvements are being made in management of the forest range. Programs of the Bureau of Land Management and the U.S. Forest Service (the two principal public administrators of the forest range) include: closer control of number of livestock, construction of check dams and reservoirs, contour trenching, more use of rotation and deferred grazing practices, and control of juniper and sagebrush followed by reseeding of thousands of acres to desirable species of grass and browse. Cooperative programs of public agencies and livestock operators have also been carried out successfully in several parts of the State.

Many of the methods for improving winter ranges for big game were developed cooperatively by the Utah State Department of Fish and Game and the Intermountain Forest and Range Experiment Station.

The photo above shows sheep on meadow and forest range at about 9,000 feet on the Manti-LaSal National Forest. Many thousands of acres of aspen lands—similar to those on the slope in the background—provide excellent forage of forbs, shrubs, and grasses for Utah livestock and game. In some places, such as large areas on the Dixie National Forest, very heavy browsing by big game and domestic livestock has eliminated most of the aspen reproduction. This has accelerated the takeover by coniferous trees and the consequent deterioration of forage values. This situation typifies the complex problems in multiple use management in Utah.

The photo on the right shows range revegetated for livestock and deer. These cattle are grazing on an area where scattered pinyon-juniper and ponderosa pine grow at an elevation of 8,000 feet on the Paunsaugunt Plateau, Dixie National Forest. This is part of about 25,000 acres revegetated by drill seeding between 1948 and 1950.

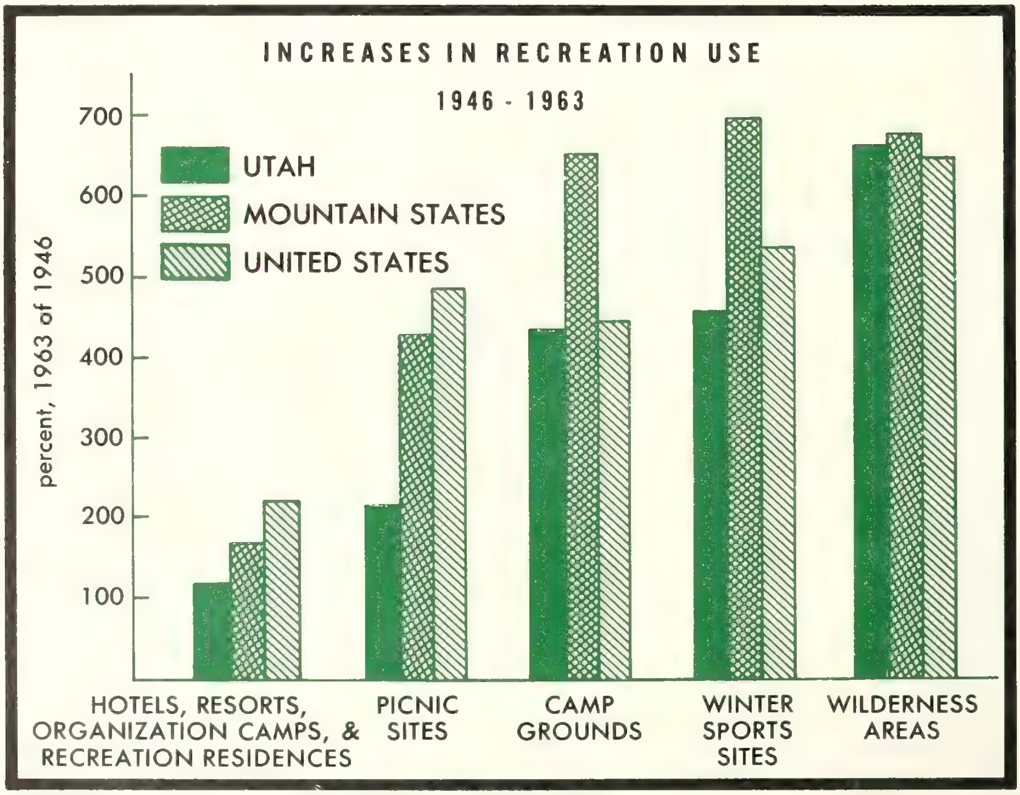
Recreational use of forests is especially intense in Utah

Utah's forested mountains, which attract campers, picnickers, hunters, skiers, and many others, are some of the most heavily used recreational lands in the West. Use is especially heavy on the forest area along the heavily populated Wasatch Front.[9] For example, in 1963 the Wasatch National Forest ranked third in recreational traffic among the 154 National Forests in the United States. The official tally showed 3.2 million man-days of recreation use.

There are also indications that Utah ranks first among the Mountain and Pacific Coast States in recreation visits per acre of forest land. Although figures are not available on the recreation use of all forest lands by States, National Forest estimates of number

Photos on the facing page show some of the opportunities for year-round forest recreation in Utah. A chair lift on sparsely timbered upper slopes at Alta Ski Area, Wasatch National Forest, is illustrated in the upper photo. Skiing conditions in many of Utah's forest areas, particularly on the Wasatch Mountains, are unexcelled in the United States. The long ski season, with fluffy, dry, powder snow, results in heavy local and out-of-state use of ski facilities and expenditures of several million dollars a year by skiers. Facilities at major ski areas such as Alta, Brighton, and Park City are constructed and operated by private enterprise on both public and private lands. These ski areas and others are important in the year-round use of Utah's forest lands for recreation.

Lower right photo shows a campground in Sheep Creek Canyon, Ashley National Forest. This is one of about 215 campgrounds on State and Federal lands in Utah. Brilliant autumn foliage of aspen in contrast with dark evergreens, against a background of massive upthrust and eroded rock formations, creates major scenic attractions in many areas of the State.



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[9] *In 1960, 82 percent of Utah's 891,000 people lived in the six Wasatch Front counties — Cache, Box Elder, Weber, Davis, Salt Lake, and Utah.*

of visits by recreationists do permit certain comparisons.[10] On this basis, the following tabulation shows Utah's preeminent position in 1963 in relation to other leading States, and in comparison with averages for western regions and the country as a whole.

	Number of visits per 1,000 acres of National Forest Land
Utah	1,127
Colorado	909
California	886
Mountain States	539
Pacific Coast States	665
United States	673

The number of visits to Utah's National Forests by class of use in 1963 were as follows:

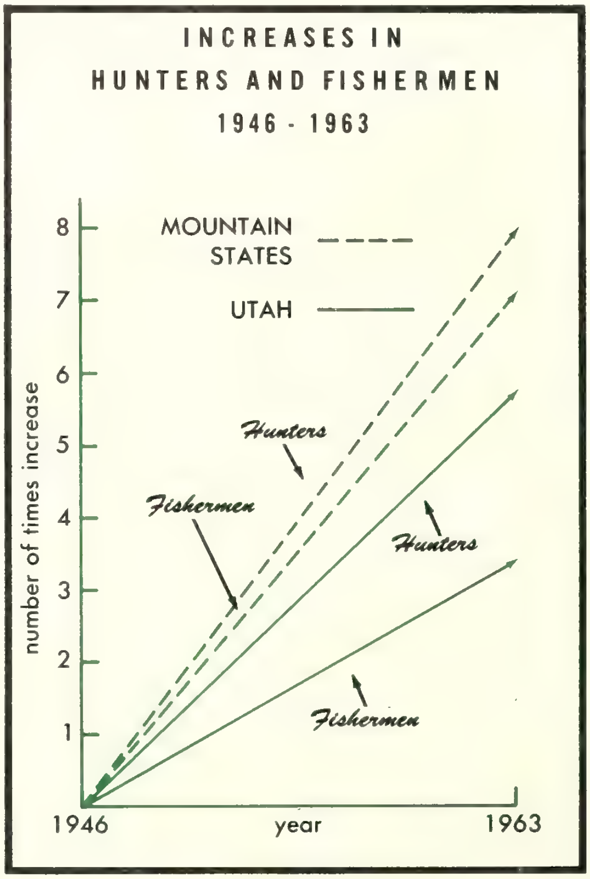
Picnic sites	2,617,900
Campgrounds	1,499,200
Winter sports sites	662,000
Hotels or resorts	75,600
Organization camps	68,700
Recreation residences	64,800
Wilderness areas	45,400
Other forest areas	3,847,900
Total	8,881,500

Many forest recreation areas outside the National Forests are probably just as heavily used. Private enterprises, both inside and outside National Forests, provide facilities for skiing, boating, pack-tripping, and other activities. The Utah State Park and Recreation Commission, National Park Service, and Bureau of Land Management all have active programs to foster outdoor recreational use of the forests.

Although Utah is the leading western State in intensity of recreation use of the forests (as indicated by National Forest data), the State has been falling behind in the *rate* of increase in recreation traffic since World War II (chart page 26). This situation is also illustrated by estimates of Utah's share of the recreation visits to National Forests of the Mountain States. In 1946, 36 percent of the visits were in Utah, but by 1963 the percentage dropped to 18. In other words, while Utah had a head start, other States have been catching up.

As in every other State, hunting and fishing have become increasingly popular since World War II. Between 1946 and 1963 there was almost a sixfold increase in the number of visits to National Forests for hunting deer, elk, moose, bear, and upland game birds. During the same period the number of visits by fishermen increased about 3.4 times. As shown by the chart on this page, both of these increases are less than Mountain States averages.

The estimated legal take of 96,000 head of big game on the National Forests in 1963 represents a substantial increase over the 35,000 in 1946.


INCREASES IN HUNTERS AND FISHERMEN 1946 - 1963

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[10] *National Forest statistics on number of recreation visits are used here and elsewhere in this report for two reasons: (1) they are practically the only data available for forest land as distinguished from all lands that are used for outdoor recreation, and (2) they permit ready comparisons among States.*

Timber cut and economic returns are low in relation to inventory

Utah's forests have never been heavily exploited for timber. In contrast to the very high value of forest lands for water, capacity use of the forest range, and the bustling demands of recreation, timber use has been moderate. Millions of trees have grown to sawtimber size and died without the touch of an ax or a saw.

Many factors discourage timber operations in Utah. Size of trees, grades of logs, and volumes per acre are generally less favorable for logging in Utah than in most areas of the Mountain States. Steep slopes, delicate soils, and the isolated location of much of the best timber result in high costs for constructing roads that will not cause erosion. As a result of these various considerations, a great many stands (although classed as commercial forest) are not profitable logging chances. This is particularly the case when the timber operator is required to bear all, or even a major portion of road construction costs. In other stands classed as commercial, existing or planned use of the forest for recreation or other purposes limits timber-harvesting opportunities. These limiting factors, as well as other considerations that enter into long-term timber management planning in Utah, are discussed later in this report.

In 1962, Utah's cut of 12.6 million cubic feet was only one-fifth of 1 percent of its inventory of 5.8 billion cubic feet of sound live trees. The following tabulation shows how low this cut is in comparison with other Mountain States and the United States.

	Percent of inventory cut, 1962, all species
Utah	0.22
Colorado	.22
Wyoming	.29
Nevada	.36
New Mexico	.60
Montana	.83
Idaho	1.02
Arizona	1.08
Mountain States	0.69
United States	1.62

Relationships among Mountain States are almost the same when sawtimber cut is considered in relation to sawtimber inventory.

Utah's low cutting rate is the principal factor in a low rate of economic returns from the timber resource. Data for 1958[11] (U.S. Forest Service 1963) can be used to compare Utah with the Mountain States average by certain economic measures. For 1958 the stumpage value of $47.62 per thousand cubic feet of timber cut in Utah was practically as high as the $48.84 average for the Mountain States. However, as shown in the following tabulation, Utah is far below the Mountain States average when value of products shipped from primary manufacturing plants[12] is related to the inventory of wood in the forest.

	Value of shipments	**Value of shipments per billion cubic feet of inventory**
	- - - Thousand dollars - - -	
Utah	6,000	1,030
Mountain States	319,300	3,300

The primary reason for the low value shown above for Utah (actually the lowest of all Mountain States) is the small amount of wood processed in comparison with inventory volume. A related reason is that Utah does not have industries that convert wood to relatively high-value products such as plywood and pulp and paper. Utah is at a disadvantage in comparison with the West Coast in producing for national markets. The extensive areas of big timber on the coast favor establishment of large integrated mills with lower production costs.

A number of roadblocks standing in the way of a rapid increase in timber cut are discussed later in this report. To the extent that these problems can be reduced, the people of Utah will realize greater returns in wages, profits, and taxes from more timber harvesting and bigger wood conversion industries.

[11] *1958 is the latest year for which there is Census of Manufactures data of the type used for this analysis.*

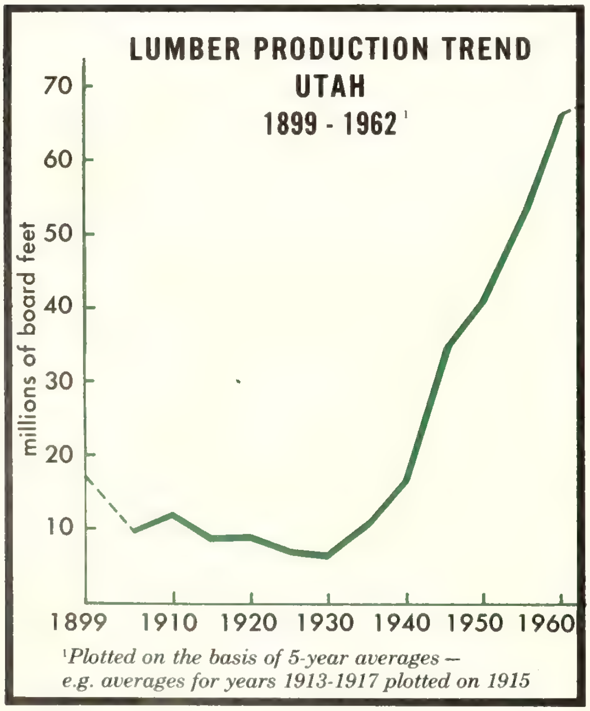
[12] *Includes sawmills and planing mills, veneer and plywood plants, paper and paperboard mills, and miscellaneous products plants.*

Lumber is the principal timber product

Although demands for Utah timber have not been widespread and though the harvest and economic returns have always been well below the potential, local timber has played a very important role in the development of this State, as well as adjoining areas. The first sawmill was established in 1847, shortly after the arrival of the Mormon vanguard. As settlements spread from the Salt Lake City area, more mills were established to provide lumber for local development. In 1889 Utah had 30 sawmills. Undoubtedly, during these early years much less timber was used for lumber than for fuel and roundwood products such as houselogs, poles, posts, railroad ties, and mine timbers. In 1867-69 tracks of the transcontinental railroad were laid on countless ties that had been hewn by hand from lodgepole pine on the north slope of the Uinta Mountains and floated down such streams as the Blacks Fork and Smiths Fork. Other areas were also selectively cut for tie timber as railroads were built throughout the State. Local forests also have been the source of round mine props for underground coal mines and metal mines.

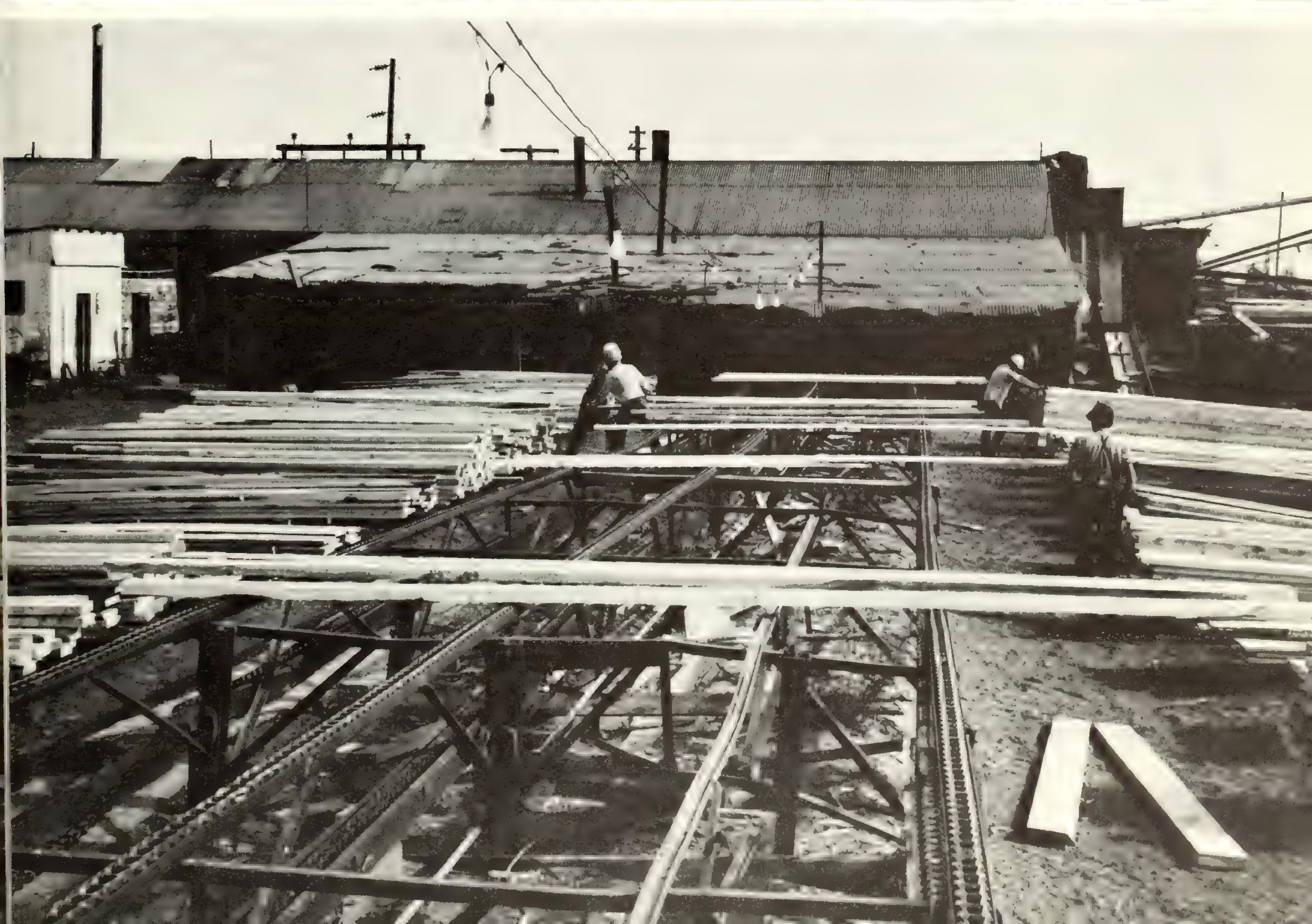
In recent years roundwood products have gradually been replaced by sawed material. In 1962, 90 percent of all roundwood products was in saw logs for lumber.

	Thousand cubic feet
Saw logs (for lumber)	**10,845**
Converter poles, excelsior bolts, charcoal wood, and commercial poles	**703**
Round mine timbers	**245**
Posts, fuelwood, miscellaneous farm timbers	**212**
Total	**12,005**



[1] *Plotted on the basis of 5-year averages — e.g. averages for years 1913-1917 plotted on 1915*

Harvesting and milling saw logs in southern Utah (photos on facing page). The Crofts-Pearson Industries truck shown in the upper photo is hauling ponderosa pine logs from a Dixie National Forest timber sale on the Paunsaugunt Plateau, to the company's mill at Panguitch. The lower photo shows lumber being sorted and piled from the green chain after logs have been cut by gangsaws. Subsequent operations will include kiln drying and planing. This sawmill, with an output of about 120,000 board feet a day, is by far the largest in Utah.



UTAH SAWMILLS AND SAWLOG PRODUCTION
1962

● Sawmill reported as operating in 1962

Sawlog output by county in million board feet

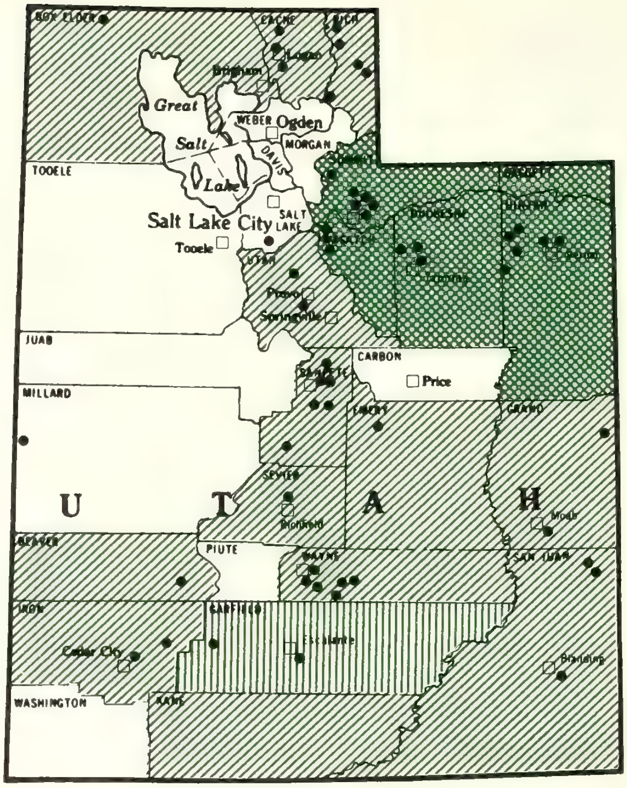
☐ No reported production

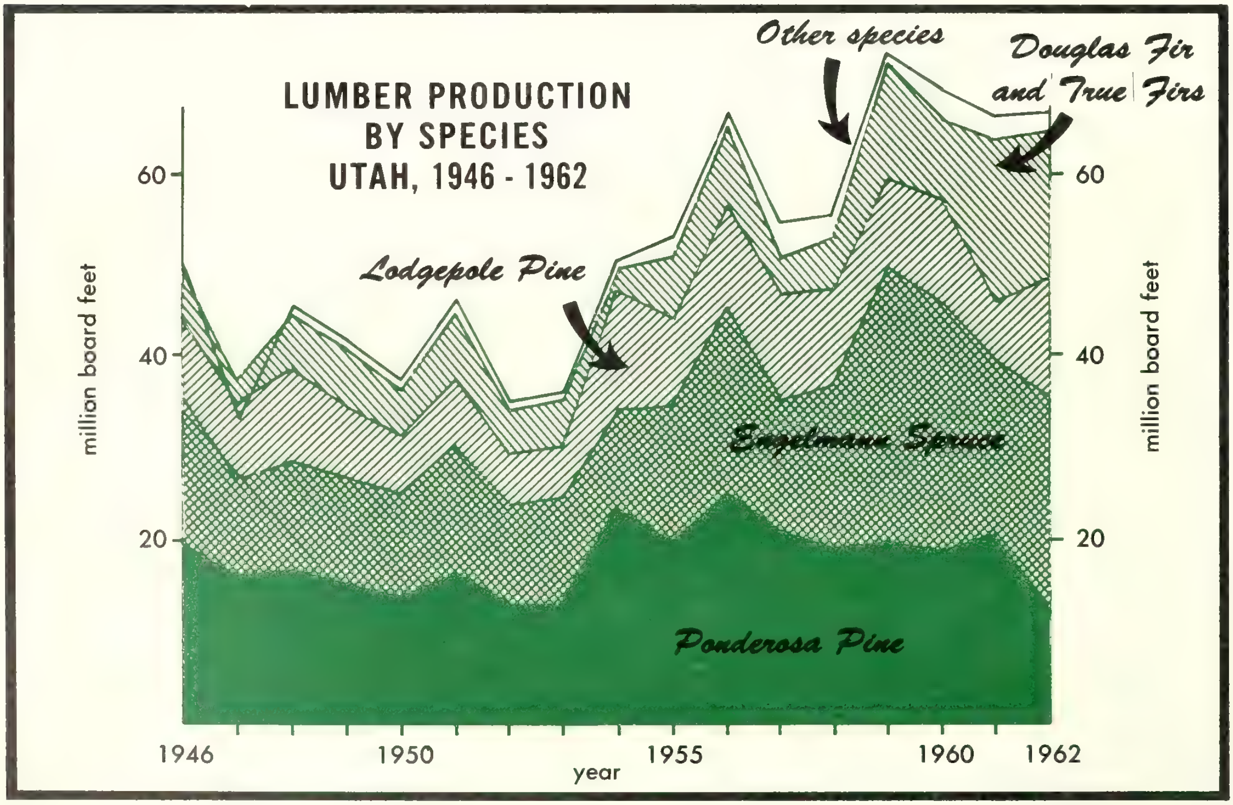
▨ Less than 5

🟩 5 to 10

▥ More than 10

In addition to the mills plotted on the map, there were an estimated 19 active mills, all small, for which no sawlog reports were received in the 1962 products survey. These mills received about 5.1 percent of the State's sawlog output in 1962.





There was a fairly steady upward trend in annual lumber production from the early 1930's until 1960; since then production has leveled off (chart on this page). Figures for lumber and total of all products cut in recent years are as follows:

	Lumber *Million board feet*[1]	**All products** *Million cubic feet*
1952	**35**	**8.8**
1960	**69**	**14.8**
1962	**67**	**12.0**

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[1] *Lumber tally as estimated for Utah by the U.S. Bureau of the Census.*

Utah's lumber industry has not been stable. Between 1889 and 1940, the number of mills fluctuated between 30 and 95. From 1941 to 1948 more than 100 mills were in operation, with a peak of 170 in 1948. By 1962, however, only 73 plants were operating. The number of mills by size classes were as follows:

Sawmill size class (Thousand board feet per year)	*Number of mills*[1]
Less than 50	**19**
50 to 499	**33**
500 to 999	**4**
1,000 and over	**17**
Total	**73**

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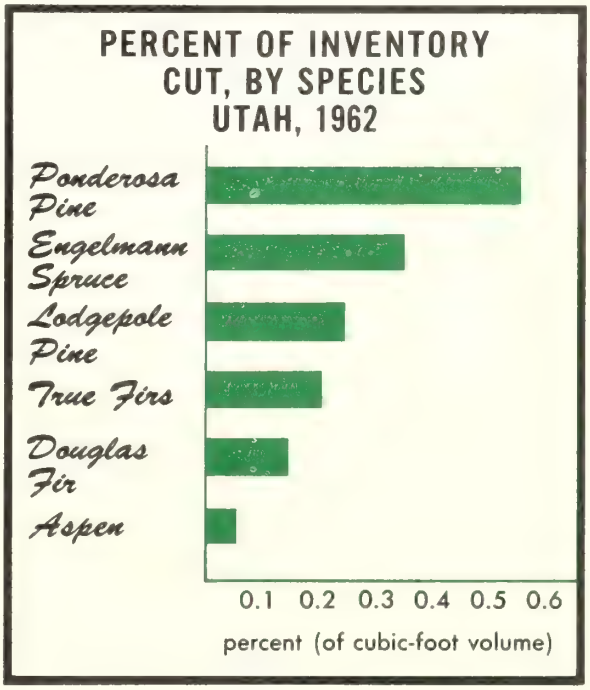
[1] *The classification of individual mills was estimated from saw log receipts rather than from lumber production.*

In Utah, as in the other Mountain States, the recent trend is toward fewer, but larger and more efficient, mills. The number of active mills in Utah dropped from 99 in 1960 to 73 in 1962; the concurrent increase in the State's lumber production resulted in greater average annual production per mill. This increase was from 700,000 to 918,000 board feet.[13]

The map on the facing page shows the geographic distribution of active sawmills and indicates the principal counties that produce saw logs. Garfield County was the only county that produced more than 10 million board feet of saw logs in 1962.

Since the early days of lumbering in Utah, there have been important shifts in the relative importance of species. In Utah, more ponderosa pine has been cut into lumber than any other species. The excellent lumber properties of ponderosa pine, as well as relative accessibility of the timber, have resulted in heavy use of this species ever since lumbering began. Despite year-to-year fluctuations in the volume of ponderosa pine cut since World War II, the overall trend has been fairly level—with an average of 18 million board feet a year. During this period the output of other species has increased, as shown by the chart on the facing page.

Engelmann spruce replaced ponderosa pine as the leading species in 1959, and in 1962 accounted for slightly more than one-third of the total lumber output. The chart on this page compares species in terms of cut in relation to inventory in 1962.



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[13] *Lumber tally.*

THE FUTURE

Demands on the forest will increase

To the extent that past trends are indicative of the future, it is very evident that Utah's forests will receive much greater use in the coming years. This is portended not only by trends within the State (as discussed earlier in this report) but also by national and regional forecasts.

Projections of demands for water, recreation, timber, and other resources indicate big increases by 2000. However, the projected rate of increase differs substantially among resources. And projections for an individual use can vary greatly depending on assumptions relative to technological changes, use of competing resources, disposable income, amount of leisure time, etc. A basic assumption, of course, is the extent of increase in the country's population. The latest median projection by Bureau of the Census indicates that the present population of 193 million people will increase to about 325 million by 2000.

Demands on forest lands for water will be much greater than they are now. A projection for the West[14] by Resources for the Future, Inc. (Landsberg et al. 1963) indicates that use of water for irrigation, municipal, and other consumption will increase more than 1.5 times between 1960 and 2000. Projected demands for hydroelectric and recreation uses are also much greater than at present.

Recreation demands will probably develop extremely rapidly. According to the report of the Outdoor Recreation Resources Review Commission, outdoor recreation in general will probably increase threefold in the United States by 2000 (Outdoor Recreation Resources Review Commission 1962). Much larger increases for forest recreation than this are suggested by other national projections for use of certain types of public recreation areas (Landsberg et al. 1963).

	1960	2000
	Million visits	
National Parks, Monuments, and Recreation Areas	**41**	**390**
National Forests	**93**	**2,010**
State Parks	**259**	**2,770**

National demands for timber are also projected to increase sharply by 2000. Recent estimates (U.S. Forest Service 1965) indicate an increase of 81 percent in the total volume of roundwood products. Pulpwood demand is expected to increase more rapidly than this—about 2.7 times.

Utah's forests probably will be in an increasingly favorable location with respect to markets for wood products. The especially rapid growth in population of the West since World War II has meant bigger markets for lumber from the Mountain States. An increasing amount of lumber from these States is going to California. That this trend will continue is suggested by population projections which indicate that by 2000 the population of the Pacific Coast States will be about 2.2 times the number in 1960. The estimated increase for the country as a whole is 1.8 times. This changing distribution of population should favor an improving market for Utah timber.

The extent to which demands can be met in the future undoubtedly depends on greatly intensified multiple use management. There is likely to be some reduction in Utah's forest area in coming years to meet needs for rights-of-way, for highways and utility lines, reservoirs, urban expansion, and farmlands. Management that is coordinated with respect to water, timber, recreation, and forage values is already the objective on practically all public lands. Intensified management will be necessary in the years ahead.

[14] *Roughly, the area west of 95° longitude, exclusive of the Pacific Northwest.*

More information about forest lands is a basic requirement for future management. Much more and better inventory data are needed to evaluate present forest conditions and management needs, and to estimate the potential of forest lands for various uses. However, efficient data collection and its application in on-the-ground management will not be possible without much more research in all fields of management in Utah. Studies in water, range, wildlife habitat, timber management, forest protection, and timber utilization have been underway for many years. Relatively new fields of study in Utah include recreation, timber marketing, and multiple use management.

The concluding sections of this report are concerned primarily with timber management needs and industrial opportunities for timber development.

A steadily increasing supply of timber depends on farsighted management

Capability of the land to produce timber is not one of the reasons that Utah cut only 67.3 million board feet of sawtimber in 1962. This volume is about equal to the annual yield potential, without management, of the ponderosa pine lands alone (432,000 acres or 10.8 percent of the commercial forest area). Data are not available for making direct estimates of the capability of lands occupied by other timber types. If their timber-growing capability is the same as for ponderosa pine, the entire 4 million acres of commercial forest has an annual potential of roughly 616 million board feet. This is undoubtedly a conservative estimate because the potential for ponderosa pine lands is generally considered as substantially lower than the average for the commercial forest. Regardless of its magnitude, the timber potential can never be realized, because of overriding considerations of other uses on much of the area.

Many things must be considered in pushing the timber cut to higher and higher sustainable levels. Some of the factors, especially present forest conditions, have already been described in this report. These and other general considerations can be summarized as shown below.

PRINCIPAL TIMBER MANAGEMENT CONSIDERATIONS

FOREST LANDS ARE EASILY DAMAGED AND DIFFICULT TO REPAIR.

Very careful management is necessary to maintain enough vegetative cover to prevent erosion on lands where rainfall is low and erratic, slopes are steep, and soils thin and unstable.

A BIGGER PROPORTION OF THE AREA NEEDS TO BE IN VIGOROUS YOUNG STANDS.

To attain the distribution of age classes desirable for sustained yield management, there should be a reduction in the area of old growth that is risky to hold and costly to protect from insects and diseases.

MANY MORE ROADS MUST BE BUILT BEFORE THE TIMBER MANAGEMENT EFFORT CAN BE SUBSTANTIALLY INCREASED.

Lands that are presently accessible have been cut over. Roads are needed for stand protection and improvement, and for timber harvesting.

A GREAT MANY MATURE STANDS WOULD BE UNPROFITABLE LOGGING CHANCES IF OPERATORS WERE REQUIRED TO BEAR ACCESS ROAD COSTS.

Small size of trees, low volumes per acre, low-grade logs, and patchy distribution of stands are factors that make many stands marginal at best.

STAND IMPROVEMENT WORK OF ONE KIND OR ANOTHER IS ESSENTIAL.

Thinning, planting and other types of work are a necessary part of a full management program.

TIMBER MANAGEMENT MUST BE GEARED TO MULTIPLE USE MANAGEMENT.

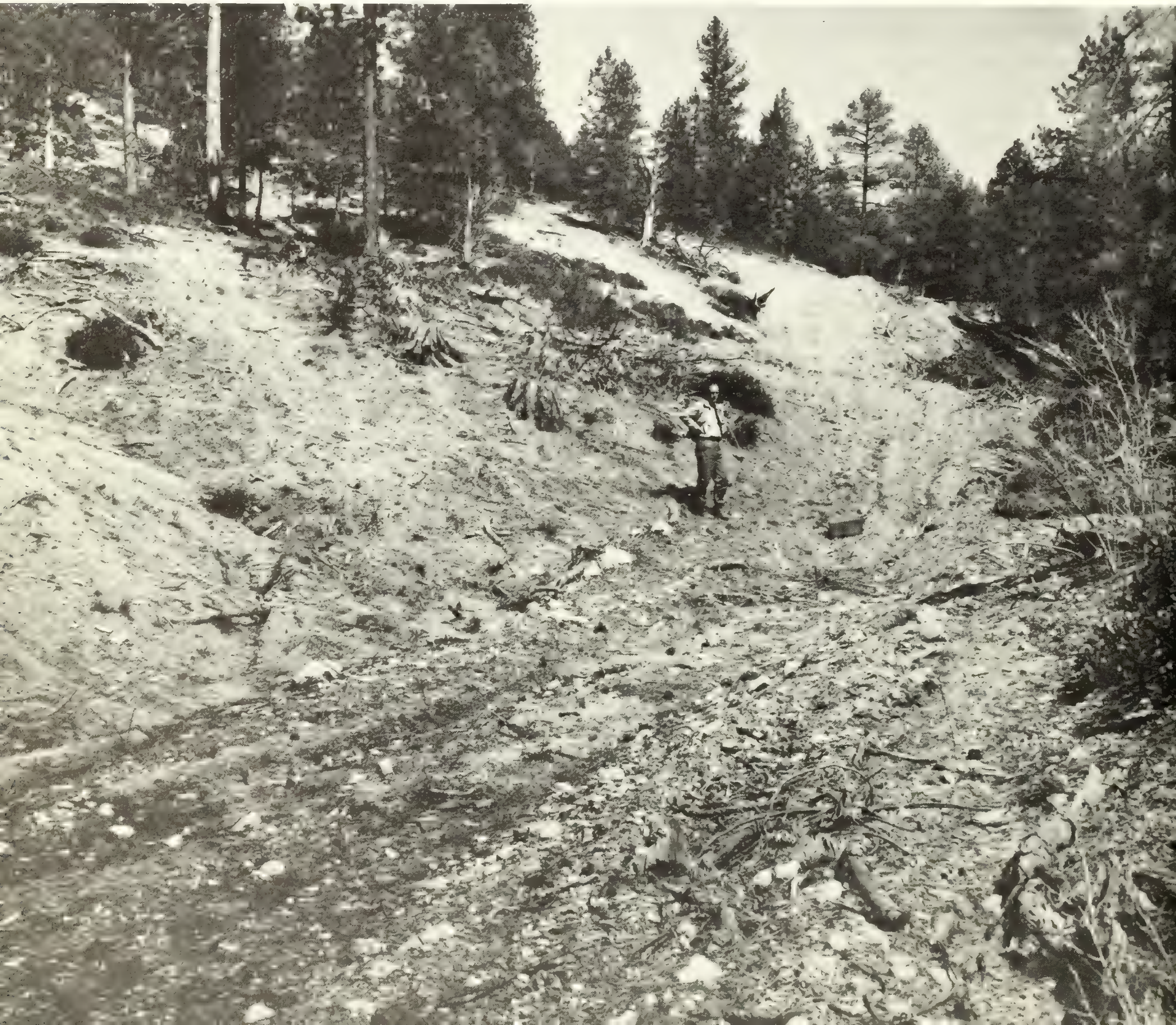
Practically no public lands will be managed for timber products alone.

TIMBER YIELDS MUST BE SUSTAINED.

Industries based on the timber resource must be assured of a steady, and desirably an increasing, supply of timber from year to year.

None of the considerations listed on the previous page can be neglected in a program directed toward full and sustained use of Utah's forests. The most basic consideration is the extremely fragile nature of the country. Unless road construction, logging, and management practices in general are designed very carefully, consequences can be serious. Once removed, many kinds of vegetation take a long time to come back. And on the tilted terrain typical of much of Utah's forest area, destruction of protective vegetation or plant cover usually promotes erosion—erosion of soils and erosion of sustained yield values. Both types of erosion are evident on the numerous lands in the State that have been overused and misused in the past.

Incipient erosion following logging on the hillside above Tropic Reservoir, Dixie National Forest. Prevention of erosion and maintenance of watershed values are primary considerations in planning and conducting logging operations on the fragile lands characteristic of most of Utah's forest area. Effective erosion control in skid trails such as this would require ditching with bulldozer or slash scattering and seeding, or possibly both.



More cutting and reforestation are requirements for improved timber management

Judicious timber cutting, in one form or another, should be a principal method of increasing productivity of Utah's commercial timberlands. As pointed out earlier there is far too much old growth, in relation to area in young stands, for long-term sustained yield management. Accelerated harvest cutting is necessary to attain a distribution of age classes that eventually will result in about the same volume of timber reaching maturity each year.

In addition to timber harvesting, cutting must also be done to thin, release, and weed many immature stands. These measures are necessary to increase yields of desirable species, sizes, and qualities. Many areas will remain relatively unproductive for the next 100 years or more unless they receive cultural treatment very quickly. These include young overstocked stands and old stands of cull trees, badly infected with mistletoe, that were left from early logging. Many of the young stands will respond to thinning. The old stands present a more serious problem; on many of them, trees should be felled and burned and new trees started. Of course, lands of better site quality provide best opportunities for improving yields by cultural work.

Until more surveys are conducted it is impossible to estimate reliably the backlog of cultural needs.[15] There is little doubt, however, that a much greater stand improvement effort will be needed in the future. Accomplishments on National Forests for 1964 only, and the total for all years to date are as follows:

	1964	**To date**
	Acres	
Release and weeding	875	18,204
Precommercial thinning	3,309	5,707
Pruning	126	52,940

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[15] *Surveys currently underway will provide data on the amount, kind, and priority of cultural work needed on National Forests.*

Precommercial thinning in ponderosa pine on the Dixie National Forest, 1964. This stand is about 50 years old — almost the maximum age at which most ponderosa pine stands in Utah will adequately respond to thinning.

Regeneration, as well as timber cutting, is an integral step in farsighted management. Cutting without regenerating cutover areas is a backward step. The problem of regenerating Engelmann spruce is probably the most difficult, particularly at the high elevations at which this species grows in southern Utah. Especially careful logging techniques must be used here to assure that spruce that is cut will be replaced by spruce seedlings.

Although data are not yet available indicating the area in need of reforestation—for timber growing, erosion control, and other purposes—it is almost certain that the present program of seeding and planting should be stepped up. Areas that have been seeded and planted on National Forests are as follows:

	1964	To date
	Acres	
Seeding	542	556
Planting	1,126	4,908
Total	1,668	5,464

Some planting has also been done on private, state, and federal lands not in National Forest ownership. About 1,100 acres were planted by the end of 1963. Of these, 65 acres were planted in 1963.

Machine planting of ponderosa pine on Dixie National Forest, 1964. The National Forest planting program calls for about 50 percent of the planting to ponderosa pine and 50 percent to other species. About 30 percent of future planting will be by machine.

Cutting, reforestation, and other timber management treatments affect one or more of the other forest uses on practically every acre of the State's commercial forest. Obviously, therefore, timber management decisions should be made within the framework of a coordinated program that defines priorities among uses and management objectives of each use.

Programs for multiple use management have not been developed to the point where they adequately guide timber management in many areas of the State. This is particularly true where there is conflict because of overlapping jurisdictions. For example, while the Board of Big Game Control is responsible for controlling levels of deer population, most of the forest land on which deer feed is in Federal ownership. In many areas there is a lack of agreement among agencies and individuals about desirable deer and livestock population levels in relation to hunter and rancher demand, other forest uses, and supplies of forage and browse. Aspen is a principal browse species but is giving way to conifers over substantial areas. Objectives for timber production and animal grazing must be reconciled before managers can decide how much land should go to conifers desirable for timber and how much should be retained in aspen for forage. This is but one example of present difficulties in defining management objectives on many individual acres of public land.

A multiple-purpose road system is a basic need

For many reasons, more roads are needed for adequate timber use and management. In the first place, more roads would permit better distribution of the timber cut. Continued cutting in already accessible areas could lead to excessive reduction in inventories on these lands, while at the same time large numbers of trees are dying and rotting in remote stands. If these remote stands were accessible, they could be logged on the basis of priority of risk and other considerations for the commercial forest *as a whole*. Furthermore, the same latitude would be permitted in selecting areas in need of thinning, release, and planting.

More roads are needed for forest protection. Better access is especially important to areas of old growth that may be subject to heavy loss from insect epidemics. For example, extensive blowdowns of Engelmann spruce would undoubtedly be followed by bark beetle epidemics. Unless major areas of this species were accessible by road, control measures would be severely handicapped and big areas could be devastated very rapidly.

Timber values alone will not justify construction of a transportation network adequate for multiple use management of public forests in Utah. As pointed out earlier in this report, tree size, tree quality, and timber volumes per acre are generally less in Utah than in the principal timber producing areas of the Mountain States. Also, there are many small patches of mature timber in Utah that have insufficient volume to warrant cost of road construction in addition to other logging expenses. Such stands are especially common in northern areas of the Wasatch Mountains. Timber on steep slopes is another problem. In many places cost would prohibit construction of logging roads that would not result in excessive erosion and impairment of watershed values.

Timber, however, is only one factor in considering better access to Utah's forests. More roads must be built to meet expanding recreation use and for more intensive management of water, wildlife, and livestock resources. Therefore, planning and financing should be directed toward a multiple-purpose road system. This implies that on public lands a much greater proportion of road financing must be by direct appropriation with proportionately less dependence on timber sale money. Although the proportion of road construction financed under sale contracts has been decreasing on National Forests, it still amounted to about one-third during the period 1960-64.

National Forest managers are currently replanning their transportation system to meet objectives of the Multiple Use and Sustained Yield Act of 1960. Planning to date, though incomplete, does provide a basis for some observations. One is that fewer miles of permanent roads will be needed than envisioned in past plans. But future roads must be much better roads, and will be more costly to construct. They must be located to meet multiple use needs and built to standards required for the greater traffic expected in managing all resources—rather than primarily timber. Also, greater consideration must be given to harmonizing roads with the environment to maintain soil stability and scenic values.

The rate of road construction must be sharply increased if anticipated transportation needs are to be met. On Utah's National Forests in 1964, only 51 miles of new roads were constructed and 112 miles reconstructed. This rate of construction probably will provide less than 60 percent of the transportation network needed for timber management and use by 2000.

Bigger markets will encourage better management

In addition to more roads and greater management effort, markets are the third key to more rapid development of Utah's timber resource. Markets for lumber and pulpwood appear to offer the best opportunities. All the State's commercial species are suitable for one or the other or both of these products.

Lumber will probably continue as the principal wood product. As discussed earlier, production has been increasing at a fairly steady rate since the early 1930's; markets should continue to improve with the country's westward shift of population.

The sawmill industry would stand to gain if a market develops for pulpwood. Utah's sawmills have not had the opportunity that mills in some other Mountain States have to sell their slabs, edgings, and trim residues in the form of chips suitable for pulping. This material, which is presently waste and usually is disposed of at some expense, represents roughly one-fifth the volume of saw logs. A market for pulp chips could encourage establishment of larger sawmills—mills of sufficient capacity to warrant the substantial expense of installing debarkers and chippers.

A market for round pulpwood would provide an opportunity to use large volumes of trees that are too small or are otherwise submarginal for lumber. Many stands consist entirely of such trees. In other stands they are mixed with sawtimber trees, but cannot be used in saw log operations. For example, of the 688 million cubic feet of lodgepole pine in sawtimber stands, almost two-fifths is in poletimber trees. A market for this material not only would make more sawtimber stands economically operable, but would favor clearcutting—the usual objective of even-age management.

Although the feasibility of establishing a pulpmill in Utah appears unlikely for some time, there is a possibility of marketing pulpwood from the Uinta Mountains. A recent U.S. Forest Service study (U.S. Forest Service 1964) shows there is enough timber within a 200-mile radius of Green River, Wyoming, to support at least a 200-ton-per-day sulphate pulp and paper mill at that location. Preliminary estimates indicate an annual volume of about 82,000 cords of lodgepole pine, Engelmann spruce, and other species could be supplied from sound, live timber on the Ashley and Wasatch National Forests in Utah. Roughly 5 percent of this would be in the form of chips from sawmills. These National Forest lands can supply another 4,700 cords a year from cull and dead (but usable) trees. Still additional volumes are available on public lands other than National Forest, and on private holdings.

An opportunity to market big volumes of pulpwood from the Uinta Mountains is highly desirable. Aside from the substantial economic returns, such a market would be of enormous benefit to long-term timber management in this area.

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APPENDIX

TERMINOLOGY

Forest Land

The term *forest land* includes (a) land which is at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking, and which has not been developed for other use; (c) afforested areas.

At the time the fieldwork for this report was performed, the minimum unit of area for forest land classification was 10 acres with a minimum width of stringer strips of 120 feet.

The principal classes of forest land are:

Commercial forest land. — Forest land which is (a) producing, or is physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; (c) not withdrawn from timber utilization.

Noncommercial forest land.—Three classes of noncommercial forest land are recognized: *Productive - reserved, Unproductive - nonreserved, and Unproductive-reserved.*

Productive-reserved is public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

Unproductive indicates forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions or forest land so physically inaccessible as to be unavailable economically in the foreseeable future.

Forest Types

Forest land is classified into types on the basis of tree species; the type name is that of the predominant species. The predominant species is the one which has a plurality of (a) gross cubic volume in sawtimber and poletimber stands, or (b) the number of stems in seedling and sapling stands. Both growing stock and cull trees are considered in the classification. Forest types which occur on both commercial and noncommercial forest land are:

Douglas-fir

Ponderosa pine

Lodgepole pine

Whitebark, limber,
and bristlecone pines

Fir-spruce

Aspen

Cottonwood

Additional forest types which occur only on noncommercial forest land are:

Pinyon-juniper

Chaparral

Other (unclassified)

Tree-Size Classes

Sawtimber-size tree

A tree 11.0 inches d.b.h. or larger

Pole-size tree

A tree 5.0 to 10.9 inches d.b.h.

Seedling-sapling trees

Trees less than 5.0 inches d.b.h.

Tree-Merchantability Classes

Sawtimber tree

Live tree of commercial species, 11.0 inches d.b.h. or larger, that contains at least one 10-foot log to a merchantable top diameter and having the likelihood of eventually containing at least a 16-foot minimum saw log. Also, at least one-third of the board-foot volume must be free from rot or other defect.

Poletimber tree

Live tree of commercial species, 5.0 to 10.9 inches d.b.h., free of rot and having the likelihood of growing into a sawtimber tree.

Sapling and seedling trees

Live trees of commercial species, less than 5.0 inches d.b.h., with form and quality to qualify as potential poletimber trees.

Growing stock trees

Sawtimber trees, poletimber trees, saplings, and seedlings; i.e., all live trees except cull trees.

In discussion and tables on volumes, growth, and mortality, the term *growing stock* refers only to sawtimber trees and poletimber trees; i.e., all live trees 5 inches d.b.h. and larger (except cull trees). Saplings and seedlings are not part of growing stock in this usage of the term.

Cull tree

Live tree of sawtimber or poletimber size that is unmerchantable for saw logs, now or prospectively, because of rot or other defect, or species.

Sound cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull with at least one-half of this cull the result of sweep, crook, or other sound defect. Also included are sound trees which do not contain at least one 10-foot saw log.

b. Poletimber-size trees that are unlikely to grow into sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, crooks, or girdling by porcupine. No rot may be present.

Rotten cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull, with more than half of the cull due to rot.

b. Poletimber-size trees showing any evidence of rot in the main stem.

Mortality tree

A tree 5.0 inches d.b.h. or larger, standing or down, which has died within the past 5 years and was not a cull tree at time of death.

Salvable dead tree

Dead tree 5.0 inches d.b.h. or larger, standing or down (but not lying on the ground) which has 50 percent or more of its cubic-foot volume in sound wood.

Stand-Size Classes

Sawtimber stands

a. National Forest lands.—A stand with a minimum net volume per acre of 1,500 board feet (International ¼-inch rule) in sawtimber trees. Two classes of sawtimber stands are recognized.

b. All other lands.—At least one-fourth of the dominant trees are sawtimber trees.

Large sawtimber

a. National Forest lands.—A stand in which the majority of the net board-foot volume is in sawtimber trees 21.0 inches d.b.h. and larger.

b. All other lands.—At least one-half the dominant sawtimber trees are at least 21.0 inches d.b.h.

Small sawtimber

a. National Forest lands.—A stand in which the majority of the net board-foot volume is in sawtimber trees from 11.0 to 20.9 inches d.b.h.

b. All other lands.—At least one-half the dominant sawtimber trees are less than 21.0 inches d.b.h.

Poletimber stand

Stand failing to meet the sawtimber stand specifications, but at least 10 percent stocked with poletimber and larger trees (5.0 inches d.b.h. and larger) and with at least half the stocking in poletimber trees.

Seedling and sapling stand

A stand not qualifying as either a sawtimber or poletimber stand, but having at least 10 percent stocking of trees of commercial species and with at least half the stocking in seedling and sapling trees.

Nonstocked area

An area not qualifying as a sawtimber, poletimber, or a seedling-sapling stand; i.e., normally an area less than 10 percent stocked.

Stocking

Stocking is a measure of the degree to which growing space is utilized by trees. In this report it is expressed as the percentage of the available space that is occupied by live trees.

Well-stocked stand

A stand that is 70 percent or more occupied.

Medium-stocked stand

A stand that is 40 to 70 percent occupied.

Poorly stocked stand

A stand that is 10 to 40 percent occupied.

Nonstocked area

An area that is less than 10 percent occupied.

Timber Volume

All-timber volume

Volume in cubic feet of sound wood in the bole of growing stock, cull, and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top inside bark.

Growing stock volume

Net volume in cubic feet of sawtimber trees and poletimber trees from stump to a minimum 4.0-inch top inside bark.

Live sawtimber volume

Net volume in board feet, International ¼-inch rule, of the saw log portion of sawtimber trees.

Saw log portion

That portion of the bole of sawtimber trees between the stump and the merchantable top.

Merchantable top

The point at which the upper limit of saw log merchantability is limited either by limbs or by a minimum diameter. The latter varies with diameter class, ranging from 5 inches inside bark for trees 11 inches at breast height to 10 inches for trees 26 inches or larger.

Upper-stem portion

That part of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches inside bark.

Growth

Net annual growth of sawtimber or growing stock

The average annual change, calculated from the total change over a 10-year period, in net board-foot or cubic-foot volume of live sawtimber or growing stock on commercial forest land.

Mortality

Net annual mortality of sawtimber or growing stock

The average annual net board-foot or cubic-foot volume removed from live sawtimber or growing stock through death, calculated from the total net volume removed by such causes over a 10-year period.

Timber Cut

Timber cut from growing stock

The volume of sound wood in live sawtimber and poletimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Timber cut from sawtimber

The net board-foot volume of live sawtimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Logging residues from growing stock

The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging on commercial forest land and not converted to timber products.

Ownership Classes

National Forest lands

Federal lands which have been designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the United States Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Other Federal lands

Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies.

State lands

Lands owned by the State.

Farmer-owned lands

Lands owned by operators of farms.

Miscellaneous private lands

Privately owned lands other than forest-industry or farmer-owned lands.

Principal Tree Species

Softwoods	
Douglas-fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Fir, white	*A. concolor*
Juniper	*Juniperus*
Pine, limber	*Pinus flexilis*
Pine, lodgepole	*P. contorta*
Pine, ponderosa	*P. ponderosa*
Pine, whitebark	*P. albicaulis*
Pine, bristlecone	*P. aristata*
Pinyon	*P.*
Spruce, Engelmann	*Picea engelmannii*
Spruce, blue	*P. pungens*
Hardwoods	
Aspen, quaking	*Populus tremuloides*
Cottonwood, black	*P. trichocarpa*

SURVEY METHODS[16]

Area statistics were determined by two methods: (1) Mapping on aerial photographs was done on about 3.0 million acres of forest. Primary delineations of forest areas were into commercial and noncommercial classes. Commercial forest areas were further subdivided into types, stand-size classes, and stocking classes. Photo delineations were then transferred to base maps. Dot counts were made on maps to obtain estimates of area of commercial and noncommercial forest, and subdivisions of commercial forest. (2) Sampling was done on a forest area of 11.8 million acres (1.5 million acres of National Forest and 10.3 million acres in other ownerships). Points were classified on aerial photos to determine the proportion of area by forest and nonforest and by class of forest. Ownership of lands other than National Forest was also determined by sampling. A percentage of photo points was checked on the ground for correctness of interpretation of land class. Results of the field check were then used to adjust photo estimates of proportions. Acreages were determined by applying the adjusted proportions to the gross area as determined from maps.

Volume estimates are based on tree measurements taken on 2,184 sample areas located at random on commercial forest lands. Sample locations were pricked on aerial photos then located on the ground and established on a permanent basis to permit remeasurement on future surveys. Two somewhat different sampling procedures were used: (1) On National Forests measurements were taken on circular plots of fixed radius. On some Forests one plot was taken at each sample location, on others two plots were measured. Each plot consisted of four circular and concentric subplots. The area of subplots and kind of trees tallied on them are as follows:

1/500-acre—live seedling-sapling size trees
1/50-acre—live pole-size trees
1/5-acre—live sawtimber-size trees, and all salvable dead trees (poletimber size and sawtimber size)
1/3-acre—mortality trees, pole size and larger

(2) On lands not in National Forest ownership sample locations were 1 acre in size. Each location was subsampled at 10 points. At each point trees were tallied on two plots—one of fixed radius (1/250-acre) and one of variable radius. On the former all trees were measured and live trees were classified as crop trees or excess trees from the standpoint of management treatment. The variable radius plot (trees are sampled in proportion to their basal area) was used for live sawtimber trees and for mortality trees.

Under both of the systems described above the customary measurements and classifications of trees were made for volume and quality, and increment borings were taken for growth estimates.

Formulas equating field measurements to volume, growth, and mortality were applied as part of the machine data processing to provide average volumes per acre for the various classifications based on type, size, stocking, etc. These averages, applied to area estimates, provided volumes shown in statistical tables.

Estimates of timber cut are based on periodic surveys of forest industries. The latest surveys are for 1962 and are the basis for data shown in the appendix tables. Utilization trends discussed in the text are based mainly on lumber production data, since complete information on output of all products for years prior to 1960 is not available. Data for estimating the volume of logging residues are obtained by special studies on active woods operations.

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[16] *Methods described here are those that were used for inventorying all forest lands except the 280,302 acres of forest within the Navajo and Uinta-Ouray Indian Reservations. Data for these lands were provided by the Indian Service from their management plan inventory.*

RELIABILITY OF ESTIMATES

Data collected by sampling are not entirely reliable; i.e., there is a sampling error. Sufficient samples are taken to insure that the error is not above a specified maximum. Magnitude of the errors associated with area and volume estimates for Utah have been determined by statistical analysis of the data.

Estimates of the acreage of the various classes of forest land were determined by two procedures—mapping (3.0 million acres) and sampling (11.8 million acres). There are no sampling errors for the mapped area. Sampling errors for the sampled portion and for the total estimates of commercial and noncommercial breakdowns are shown in the following tabulation:

	Mapped area		Sampled area			Total forest area		
	Area *M acres*	*SE*	*Area* *M acres*	*SE* *Acres*	*SE* *Percent*	*Area* *M acres*	*SE* *Acres*	*SE* *Percent*
Commercial	1,733	0	2,266	27,192	1.20	3,999	27,192	0.68
Noncommercial	1,307	0	9,559	81,252	.85	10,866	81,252	.75
Total	3,040		11,825			14,865		

The sampling error for the estimated 5,825 million cubic feet of growing stock in Utah is ±2.5 percent.

The sampling error for the total timber cut from growing stock (12,558,000 cubic feet) is estimated at ±3.25 percent.

All errors are computed on the basis of odds of two out of three that values which would result from a 100-percent survey would lie within the range indicated by the error.

SPECIAL NOTE — SAWTIMBER CLASSIFICATION

The following statistics for Utah classify all trees 11.0 inches in diameter and larger as sawtimber. The publication, *Timber Trends in the United States*, Forest Resource Report 17, Forest Service, U.S. Department of Agriculture, February 1965, although bearing an earlier printing date, contains a subsequent adjustment of the *softwood* sawtimber category to include trees down to 9.0 inches. Estimates of the board-foot volume, growth, and mortality in 9.0- to 10.9-inch softwood trees are not available for all of the categories in the following tables. However, in those instances where the data are available the board-foot estimates for 9.0- to 10.9-inch trees are shown in a footnote.

TIMBER STATISTICS

Table 1.—**Area by land classes, Utah, 1961**

Land Class	Thousand acres
Commercial forest land	3,999
Unproductive forest land	10,701
Productive-reserved forest land	165
Total forest land	14,865
Nonforest land	37,832
All land	[1]52,697

[1] *From U.S. Bureau of the Census, Land and Water Areas of the United States, 1960.*

Table 2.—**Area of commercial forest land by ownership classes, Utah, 1961**

Ownership class	Thousand acres
National Forest	2,783
Other Federal:	
Bureau of Land Management	155
Indian	158
Miscellaneous Federal	--
Total other Federal	313
State	240
County and municipal	--
Forest industry	--
Farmer-owned	540
Miscellaneous private	123
All ownerships	3,999

Table 3.—**Area of commercial forest land by stand-size and by ownership classes, Utah, 1961**

Stand-size class	All ownerships	National Forest	Other public	Farmer and misc. private
	Thousand acres			
Sawtimber stands:				
Large sawtimber	572	75	233	264
Small sawtimber	2,057	1,782	146	129
Total	2,629	1,857	379	393
Poletimber stands	1,125	840	103	182
Sapling and seedling stands	218	80	61	77
Nonstocked areas	27	6	10	11
All classes	3,999	2,783	553	663

Table 4.—**Area of commercial forest land, by stand-volume classes for sawtimber and other stand-size classes, Utah, 1961**

Stand volumes per acre[1]	Area by stand-size classes		
	All stands	Sawtimber stands	Other stands
	Thousand acres		
Less than 1,500 board feet	1,353	16	1,337
1,500 to 5,000 board feet	1,000	968	32
5,000 to 10,000 board feet	1,315	1,314	1
10,000 to 20,000 board feet	303	303	--
More than 20,000 board feet	28	28	--
All classes	3,999	2,629	1,370

[1] *Net volume, International ¼-inch rule.*

Table 5.—**Area of commercial forest land, by stocking classes of all live trees and by stand-size classes, Utah, 1961**

Stocking class	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
70 percent or more	1,200	657	381	162	--
40 to 70 percent	909	471	411	27	--
10 to 40 percent	1,863	1,501	333	29	--
Less than 10 percent	27	--	--	--	27
All classes	3,999	2,629	1,125	218	27

Table 6.—**Area of commercial forest land, by forest types and by ownership classes, Utah, 1961**

Forest type	All ownerships	Public ownerships	Private ownerships
	- - - - - *Thousand acres*		- - - - -
Douglas-fir	646	507	139
Ponderosa pine	432	400	32
Lodgepole pine	563	531	32
Whitebark, limber, and bristlecone pines	29	18	11
Fir-spruce[1]	1,047	963	84
Aspen	1,280	915	365
Cottonwood	2	2	--
All types	3,999	3,336	663

[1] *Includes 192,000 acres of white fir type.*

Table 7.—**Area of commercial forest land by forest types and by stand-size classes, Utah, 1961**

Forest type	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	- - - - - - -		*Thousand acres*	- - - - - - -	
Douglas-fir	646	556	56	33	1
Ponderosa pine	432	403	14	8	7
Lodgepole pine	563	311	223	28	1
Whitebark, limber, and bristlecone pines	29	24	2	3	--
Fir-spruce[1]	1,047	947	77	22	1
Aspen	1,280	386	753	124	17
Cottonwood	2	2	--	--	--
All types	3,999	2,629	1,125	218	27

[1] *Includes 192,000 acres of white fir type.*

Table 8.—**Commercial forest area of lands not in National Forest ownership, by county, Utah, 1961**

County	Total commercial forest land	County	Total commercial forest land
	Thousand acres		*Thousand acres*
Box Elder	12	San Juan	28
Cache	47	San Pete	20
Carbon	113	Sevier	28
Daggett	10	Summit	160
Duchesne	88	Tooele	21
Emery	40	Uintah	62
Garfield	39	Utah	35
Grand	129	Wasatch	85
Iron	68	Washington	34
Juab	26	Weber	36
Kane	41	Beaver, Millard, Piute, Wayne	20
Morgan	39	Salt Lake, Davis	10
Rich	25		
		Total	1,216

Table 9.—**Area of noncommercial forest land, by forest types, Utah, 1961**

Forest type	All areas	Productive-reserved areas	Unproductive areas
	- - - - - -	*Thousand acres*	- - - - -
Douglas-fir	102	30	72
Ponderosa pine	33	7	26
Lodgepole pine	41	36	5
Whitebark, limber, and bristlecone pines	8	2	6
Fir-spruce[1]	187	90	97
Aspen	145	--	145
Cottonwood	1	--	1
Chaparral	1,005	--	1,005
Pinyon-juniper	9,326	--	9,326
Other (unclassified)	18	--	18
All types	10,866	165	10,701

[1] *Includes 25,000 acres of white fir type.*

Table 10.—**Volume of timber on commercial forest land, by class of timber, and by softwoods and hardwoods, Utah, 1961**

Class of timber	All species	Softwoods	Hardwoods
	- - - - -	*Thousand cubic feet*	- - - - -
Sawtimber trees:			
Saw-log portion	3,275,474	2,973,360	302,114
Upper-stem portion	342,709	248,105	94,604
Total	3,618,183	3,221,465	396,718
Poletimber trees[1]	2,207,277	1,268,456	938,821
All growing-stock trees	5,825,460	4,489,921	1,335,539
Sound cull trees:			
Sawtimber-size trees	331,824	317,268	14,556
Poletimber-size trees	263,201	168,211	94,990
Total	595,025	485,479	109,546
Rotten cull trees:			
Sawtimber-size trees	101,530	49,552	51,978
Poletimber-size trees	156,164	9,006	147,158
Total	257,694	58,558	199,136
Salvable dead trees:			
Sawtimber-size trees	485,881	431,774	54,107
Poletimber-size trees	455,951	277,367	178,584
Total	941,832	709,141	232,691
All timber	7,620,011	5,743,099	1,876,912

[1] *Poletimber trees are trees 5.0 inches d.b.h. to 10.9 inches d.b.h.*

Table 11.—**Volume of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Utah, 1961**

Ownership class	All Species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
National Forest	4,635	3,687	948
Other public	568	438	130
Farmer and misc. private	622	365	257
All ownerships	5,825	4,490	1,335
		SAWTIMBER *(Million board feet)*[1]	
National Forest	15,951	14,243	1,708
Other public	1,843	1,711	132
Farmer and misc. private	1,727	1,439	288
All ownerships	19,521	17,393	2,128

[1] *International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note, page 47. There is an additional softwood sawtimber volume in 9.0-to 10.9-inch trees.*

National Forest	*2,309 MM board feet*
Other public	*278 MM board feet*
Farmer and misc. private	*233 MM board feet*
All ownerships	*2,820 MM board feet*

Table 12.—**Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, Utah, 1961**

Stand-size class	All species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
Sawtimber stands	4,664	4,010	654
Poletimber stands	1,134	462	672
Sapling and seedling stands	26	17	9
Nonstocked areas	1	1	--
All classes	5,825	4,490	1,335
		SAWTIMBER *(Million board feet)*[1]	
Sawtimber stands	18,150	16,624	1,526
Poletimber stands	1,346	746	600
Sapling and seedling stands	23	21	2
Nonstocked areas	2	2	--
All classes	19,521	17,393	2,128

[1] *International 1/4-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note on page 47.*

Table 13.—**Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by species, Utah, 1961**

Stand-size class	All species	Douglas-fir	Ponderosa pine	Lodgepole pine	White fir	Alpine fir	Engelmann spruce[1]	Other softwoods[2]	Aspen	Cottonwood
					GROWING STOCK *(Million cubic feet)*					
Sawtimber stands	4,664	838	421	688	306	541	1,164	52	652	2
Poletimber stands	1,134	58	12	273	7	57	50	5	672	--
Sapling and seedling stands	26	3	(3)	10	--	1	3	--	9	--
Nonstocked areas	1	--	1	--	--	--	--	--	--	--
All classes	5,825	899	434	971	313	599	1,217	57	1,333	2
					SAWTIMBER *(Million board feet)*[4]					
Sawtimber stands	18,150	3,733	1,891	2,310	1,322	1,575	5,582	211	1,515	11
Poletimber stands	1,346	116	50	219	16	133	202	10	600	--
Sapling and seedling stands	23	2	(3)	1	--	2	16	--	2	--
Nonstocked areas	2	--	2	--	--	--	--	--	--	--
All classes	19,521	3,851	1,943	2,530	1,338	1,710	5,800	221	2,117	11

[1] *Includes negligible amount of blue spruce.*

[2] *Whitebark, limber, and bristlecone pines.*

[3] *Less than 0.5 million feet.*

[4] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note on p. 47.*

Table 14.—Volume of growing stock on commercial forest land, by species and by diameter groups, Utah, 1961

Species	All classes	5.0-10.9	11.0-20.9	21.0-30.9	31.0-40.9	41.0 and larger
	Million cubic feet					
Softwoods:						
Douglas-fir	899	182	472	201	31	13
Ponderosa pine	434	35	190	159	46	4
Lodgepole pine	971	511	443	17	--	--
White fir	313	65	150	65	26	7
Subalpine fir	599	267	300	30	2	--
Engelmann spruce[1]	1,217	193	706	272	42	4
Other softwoods[2]	57	15	29	13	([3])	--
Total	4,490	1,268	2,290	757	147	28
Hardwoods:						
Aspen	1,333	939	388	6	--	--
Cottonwood	2	([3])	1	1	--	--
Total	1,335	939	389	7	--	--
All species	5,825	2,207	2,679	764	147	28

[1] *Includes negligible amount of blue spruce.*
[2] *Whitebark, limber, and bristlecone pines.*
[3] *Less than 0.5 million cubic feet.*

Table 15.—Volume of sawtimber on commercial forest land, by species and by diameter groups, Utah, 1961

Species	All classes	11.0-20.9	21.0-30.9	31.0-40.9	41.0 and larger
	Million board feet[1]				
Softwoods:					
Douglas-fir	3,851	2,427	1,151	195	78
Ponderosa pine	1,943	828	780	295	40
Lodgepole pine	2,530	2,438	92	--	--
White fir	1,338	771	374	152	41
Subalpine fir	1,710	1,532	165	13	--
Engelmann spruce[2]	5,800	3,898	1,617	261	24
Other softwoods[3]	221	151	68	2	--
Total	17,393	12,045	4,247	918	183
Hardwoods:					
Aspen	2,117	2,083	34	--	--
Cottonwood	11	3	8	--	--
Total	2,128	2,086	42	--	--
All species	19,521	14,131	4,289	918	183

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note, page 47.*
[2] *Includes negligible amount of blue spruce.*
[3] *Whitebark, limber, and bristlecone pines.*

Table 16.—Volume of salvable dead sawtimber-size trees on commercial forest land, by softwoods and hardwoods, Utah, 1961

Species group	Volume
	Thousand board feet[1]
Softwoods	2,360,450
Hardwoods	239,138
All species	2,599,588

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note, page 47. There is an additional salvable dead, softwood sawtimber volume of 616,550,000 board feet in the 9.0- to 10.9-inch trees.*

Table 17.—Net annual growth and annual cut of growing stock on commercial forest land, by species, Utah, 1962

Species	Net annual growth	Annual timber cut
	- Thousand	*cubic feet -*
Softwoods:		
Douglas-fir	5,776	1,254
Ponderosa pine	6,337	2,390
Lodgepole pine[1]	12,947	2,191
True firs[2]	872	1,794
Engelmann spruce[3]	7,818	4,137
Total	33,650	11,766
Hardwoods	22,446	792
All species	56,096	12,558

[1] *Includes minor volume of whitebark, limber, and bristlecone pines.*

[2] *White and subalpine firs.*

[3] *Includes negligible amount of blue spruce.*

Table 18.—Net annual growth and annual cut of sawtimber on commercial forest land, by species, Utah, 1962

Species	Net annual growth	Annual timber cut
	Thousand	*board feet*[1]
Softwoods:		
Douglas-fir	12,018	6,969
Ponderosa pine	23,394	13,222
Lodgepole pine[2]	13,926	12,139
True firs[3]	−370	9,901
Engelmann spruce[4]	26,542	22,928
Total	75,510	65,159
Hardwoods	19,771	2,092
All species	95,281	67,251

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note, page 47.*

[2] *Includes minor volume of whitebark, limber, and bristlecone pines.*

[3] *White and subalpine firs.*

[4] *Includes negligible amount of blue spruce.*

Table 19.—**Net annual growth and annual cut of growing stock on commercial forest land, by ownership classes, and by softwoods and hardwoods, Utah, 1962**

Species group	All ownerships	National Forest	Other public	Farmer and misc. private
NET ANNUAL GROWTH (*Thousand cubic feet*)				
Softwoods	33,650	40,031	–3,583	–2,798
Hardwoods	22,446	15,174	2,116	5,156
All species	56,096	55,205	–1,467	2,358
ANNUAL TIMBER CUT (*Thousand cubic feet*)				
Softwoods	11,766	10,657	235	874
Hardwoods	792	717	16	59
All species	12,558	11,374	251	933

Table 20.—**Net annual growth and annual cut of sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Utah, 1962**

Species group	All ownerships	National Forest	Other public	Farmer and misc. private
NET ANNUAL GROWTH (*Thousand board feet*)[1]				
Softwoods	75,510	113,803	−21,075	−17,218
Hardwoods	19,771	7,296	3,831	8,644
All species	95,281	121,099	−17,244	−8,574
ANNUAL TIMBER CUT (*Thousand board feet*)[1]				
Softwoods	65,159	59,020	1,303	4,836
Hardwoods	2,092	1,895	42	155
All species	67,251	60,915	1,345	4,991

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note, page 47.*

Table 21.—**Annual mortality of growing stock and sawtimber on commercial forest land, by species, Utah, 1962**

Species	Growing stock	Sawtimber
	Thousand cubic feet	*Thousand board feet*[1]
Softwoods:		
Douglas-fir	8,272	37,139
Ponderosa pine	920	4,768
Lodgepole pine	7,115	27,942
White fir	1,345	5,275
Subalpine fir	20,095	57,067
Engelmann spruce	12,449	54,909
Other softwoods[2]	665	3,360
Total	50,861	190,460
Hardwoods	15,526	35,539
All species	66,387	225,999

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note, page 47.*

[2] *Whitebark, limber, and bristlecone pines.*

Table 22.—**Annual mortality of growing stock and sawtimber on commercial forest land by ownership classes and by softwoods and hardwoods, Utah, 1962**

Ownership class	Growing stock			Sawtimber		
	All species	Softwood	Hardwood	All species	Softwood	Hardwood
	- - - - *Thousand cubic feet* - - -			- - - - *Thousand board feet*[1] - - - -		
National Forest lands	38,905	29,577	9,328	134,339	106,909	27,430
Other public lands	14,109	11,661	2,448	48,395	45,775	2,620
Farmer and misc. private lands	13,373	9,623	3,750	43,265	37,776	5,489
All ownerships	66,387	50,861	15,526	225,999	190,460	35,539

[1] *International ¼-inch rule. Volumes are for trees 11.0 inches d.b.h. and larger. See special note, p. 47.*

Table 23.—**Total output of timber products by products, by type of material used, and by softwoods and hardwoods, Utah, 1962**

Product and species group	Total output in standard units		Output from roundwood from growing stock		Output from roundwood from nongrowing stock		Output from plant byproducts (standard units)
	Unit	Number	Standard units	M cubic feet	Standard units	M cubic feet	
Saw logs:							
Softwood	M bd. ft.[1]	62,916	60,085	10,034	2,831	473	0
Hardwood	M bd. ft.[1]	2,022	1,931	323	91	15	0
Total	M bd. ft.[1]	64,938	62,016	10,357	2,922	488	0
Mine timbers:							
Softwood	M cu. ft.	245	147	147	98	98	0
Hardwood	M cu. ft.	0	0	0	0	0	0
Total	M cu. ft.	245	147	147	98	98	0
Miscellaneous industrial wood:							
Softwood	M cu. ft.	389	332	332	57	57	0
Hardwood	M cu. ft.	402	384	384	18	18	0
Total	M cu. ft.	791	716	716	75	75	0
Posts:							
Softwood	M pieces	16	0	0	16	16	0
Hardwood	M pieces	0	0	0	0	0	0
Total	M pieces	16	0	0	16	16	0
Fuelwood:							
Softwood	M std. cds.	1	0	13	1	94	0
Hardwood	M std. cds.	0	0	0	0	1	0
Total	M std. cds.	1	0	13	1	95	0
All products:							
Softwood	M cu. ft.	--	--	10,526	--	738	--
Hardwood	M cu. ft.	--	--	707	--	34	--
Total	M cu. ft.	--	--	11,233	--	772	--

[1] *International ¼-inch rule.*

Table 24.—**Total output of roundwood products, by source and by softwoods and hardwoods, Utah, 1962**

Source	All species	Softwoods	Hardwoods
	- - - *Thousand cubic feet* - - -		
Growing-stock trees:[1]			
Sawtimber trees	9,279	8,695	584
Poletimber trees	1,954	1,831	123
Total	11,233	10,526	707
Cull trees	0	0	0
Salvable dead trees[2]	742	723	19
Other sources	30	15	15
All sources	12,005	11,264	741

[1] *On commercial forest land.*

[2] *Includes noncommercial forest land, nonforest land, such as fence rows, trees less than 5.0 inches in diameter, and treetops and limbs.*

Table 25.—**Annual timber cut from growing stock on commercial forest land, by products and logging residues, and by softwoods and hardwoods, Utah, 1962**

Products and residues	All species	Softwoods	Hardwoods
	- - - - - *Thousand cubic feet* - - - - -		
Roundwood products:			
Saw logs	10,357	10,034	323
Pulpwood	0	0	0
Mine timbers	147	147	0
Miscellaneous industrial wood	716	332	384
Posts	0	0	0
Fuelwood	13	13	0
All products	11,233	10,526	707
Logging residues	1,325	1,240	85
Timber cut	12,558	11,766	792

Table 26.—**Annual timber cut from live sawtimber on commercial forest land, by products and logging residues, and by softwoods and hardwoods, Utah, 1962**

Products and residues	All species	Softwoods	Hardwoods
	Thousand board feet[1]		
Roundwood products:			
Saw logs	62,016	60,085	1,931
Pulpwood	0	0	0
Mine timbers	96	96	0
Miscellaneous industrial wood	26	25	1
Posts	0	0	0
Fuelwood	0	0	0
All products	62,138	60,206	1,932
Logging residues	5,113	4,953	160
Timber cut	67,251	65,159	2,092

[1] *International ¼-inch rule.*

Table 27.—**Volume of plant residues by industrial source and type of residue, and by softwoods and hardwoods, Utah, 1962**

Industrial source	Species and character of residues								
	All species			Softwoods			Hardwoods		
	Total	Coarse[1]	Fine[2]	Total	Coarse	Fine	Total	Coarse	Fine
	Thousand cubic feet								
Lumber industry	4,413	2,401	2,012	4,276	2,326	1,950	137	75	62
Veneer and plywood industry	0	0	0	0	0	0	0	0	0
Other primary industries	282	282	0	273	273	0	9	9	0
All industries	4,695	2,683	2,012	4,549	2,599	1,950	146	84	62

[1] *Unused material suitable for chipping such as slabs, edgings, and veneer cores.*
[2] *Unused material not suitable for chipping, such as sawdust and shavings.*

UTAH

1964

FOREST SURVEY — INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

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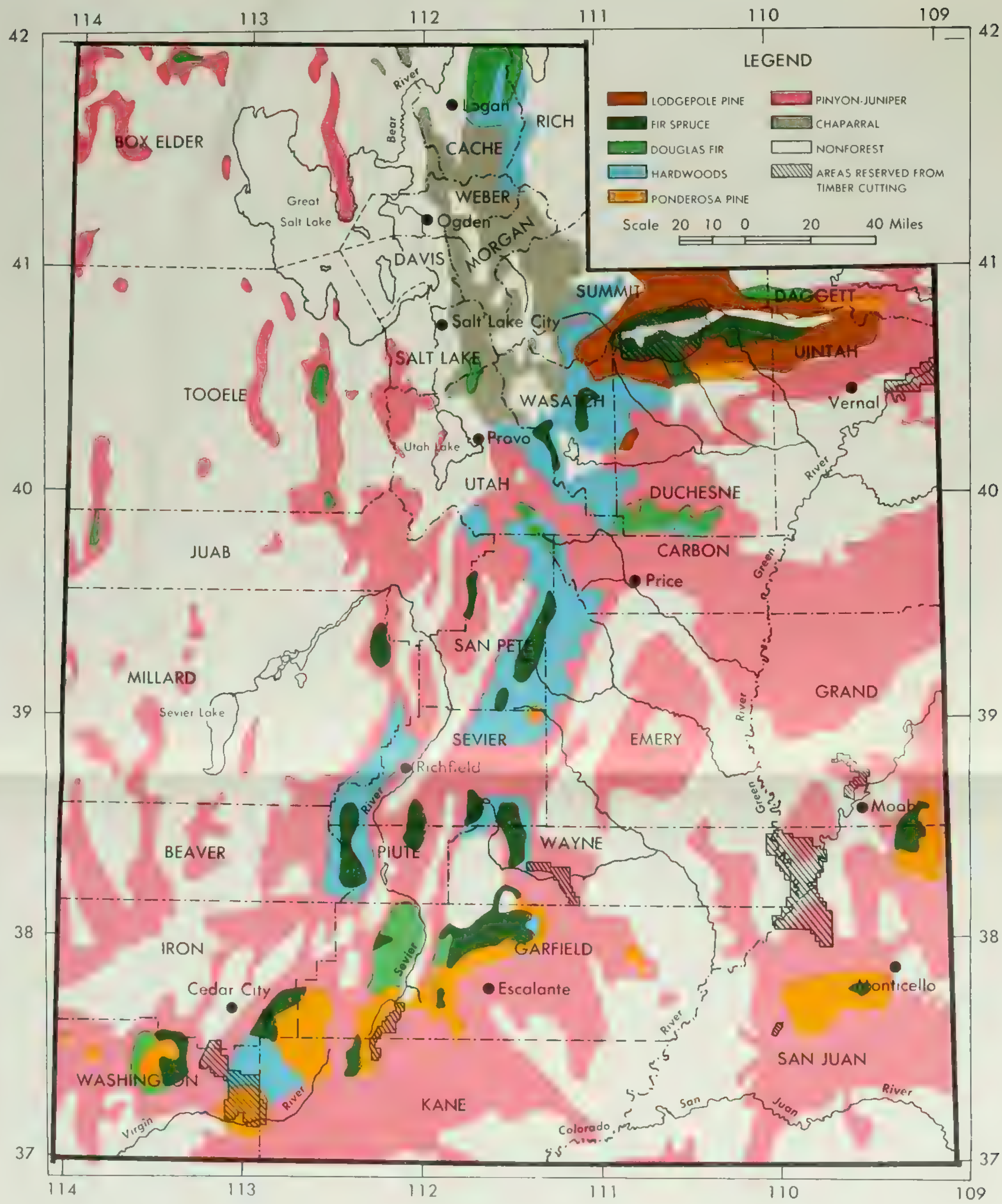

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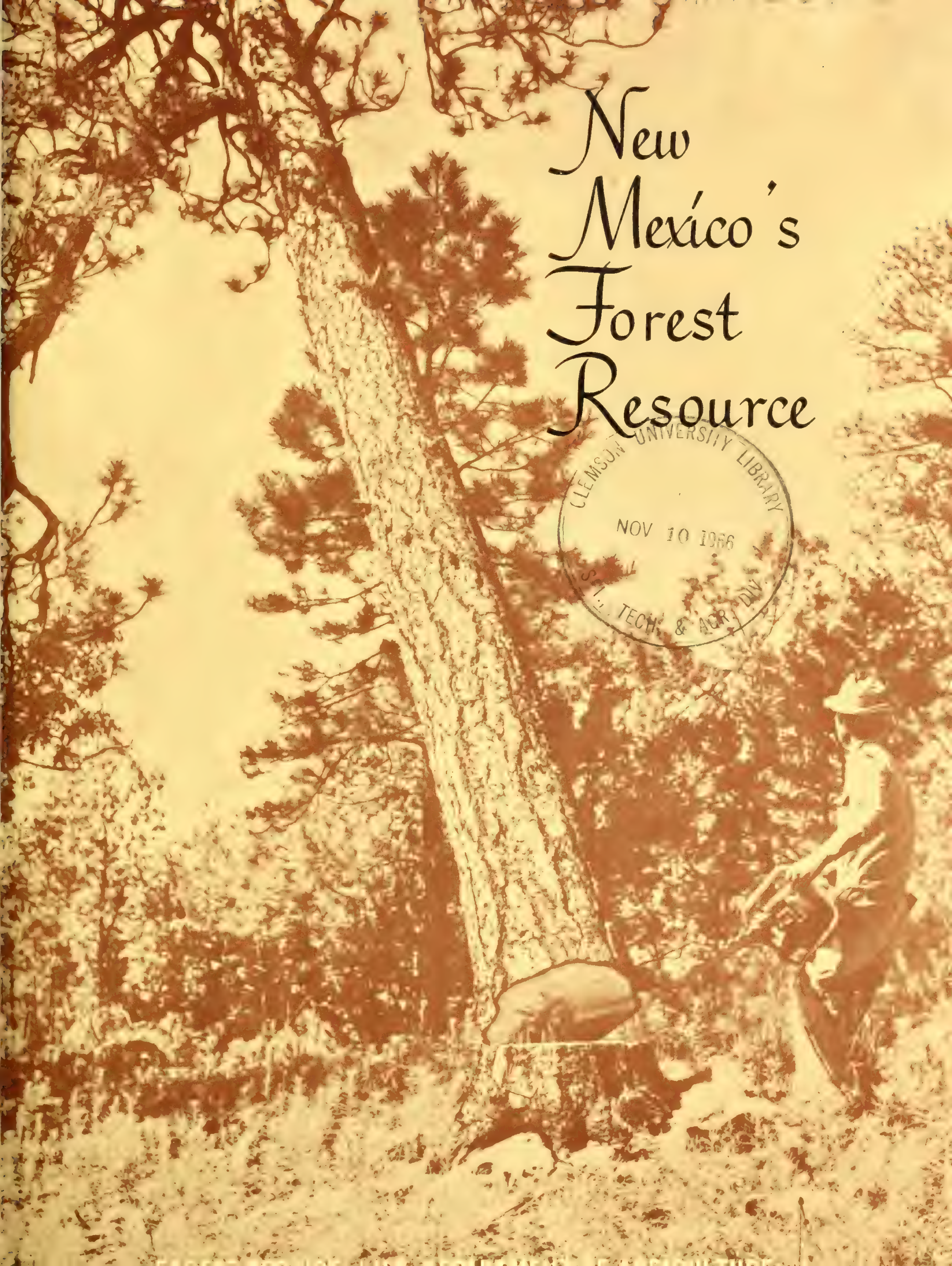

New Mexico's Forest Resource

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THE AUTHOR

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COVER PHOTOS

Photos showing timber harvesting (front cover) and forage, water, and recreation resources (back cover) illustrate some of the most important opportunities for multiple use management of New Mexico's forests.

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New Mexico's Forest Resource

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FOREST SERVICE — U.S. DEPARTMENT OF AGRICULTURE

Foreword

This report is concerned primarily with timber. It presents figures regarding significant factors bearing on the present economics of this resource. Another purpose of the report is to describe some of the most important considerations that bear on greater development of the timber resource in the future. Other forest values — water, recreation, and forage — are discussed briefly. Trends in use of these resources must be considered in relation to timber, because practically no forest lands are managed for timber alone.

Timber inventory statistics in this report are the most reliable that have ever been collected for New Mexico's forests. The Southwestern Region of the U.S. Forest Service conducted surveys of National Forests, the Bureau of Indian Affairs of most Indian reservations, and the Intermountain Forest and Range Experiment Station of other lands. A survey of timber cut and timber products output was done on a cooperative basis by the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, and the Intermountain Forest and Range Experiment Station, Ogden, Utah. The Intermountain Station compiled data from these various surveys for this report.

Meaningful comparisons cannot be made between inventory statistics in this report and those shown in the last two national timber appraisals. Differences in figures in this report from those for 1952 as shown in **Timber Resources for America's Future** (U.S. Forest Serv. 1958)[1] do not reflect actual changes in forest conditions. The 1952 figures were not based on a complete survey. Also, in the intervening years, there have been changes in standards for classifying trees and commercial forest land. Inventory statistics in **Timber Trends in the United States** (U.S. Forest Serv. 1965) were not based on a complete inventory and therefore do not agree with the figures in this report. The latter are based on fieldwork completed in 1962, but data were not available for the **Timber Trends** report because compilations were not finished until late 1964.

The appendix to this report should be consulted for definitions of terms, survey methods, reliability of estimates, and detailed timber statistics. The appendix also contains a generalized forest type map.

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[1] *Names and dates in parentheses refer to Literature Cited, p. 54.*

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Statistical Highlights

FOREST AREA

- The forested area is 18.2 million acres, or 23 percent of New Mexico's land area.
- Commercial forests cover 6.3 million acres, or 34 percent of the forest land.
- 89 percent of the 11.9 million acres of noncommercial forest is classed as pinyon-juniper type.
- 69 percent of both the total forest area and the commercial area is in public ownership. The U.S. Forest Service administers 55 percent of the commercial forest.
- There are 1.9 million acres of private commercial forest, 80 percent of which belongs to farmers and ranchers.
- 87 percent of the commercial forest is in sawtimber stands, and these stands average 5,072 board feet per acre.[2]
- The ponderosa pine type occupies 69 percent of the commercial forest area.

TIMBER VOLUME

- Commercial forests have 6.6 billion cubic feet of wood in sound, live trees, and 28.3 billion board feet in sawtimber trees.
- About three-quarters of the sawtimber volume is publicly owned.
- The predominant commercial species in terms of sawtimber volume are ponderosa pine (57 percent) and Douglas-fir (18 percent).

STAND CONDITIONS

- 47 percent of the commercial forest area, and 54 percent of the sawtimber area are in old-growth timber.
- 50 percent of the gross cubic-foot growth is offset by mortality each year.
- Diseases accounted for 55 percent of annual sawtimber mortality, and insects 30 percent in 1962.

TIMBER USE

- New Mexico's timber cut of 40 million cubic feet from sound, live trees in 1962 was 0.6 percent of inventory. This is slightly less than the average cutting rate throughout the entire Mountain States area.[3]
- 78 percent of the volume of roundwood products cut in 1962 was saw logs for lumber.
- The harvest of roundwood products (cubic volume) was 14 percent greater in 1962 than in 1952. During the same period saw log production went up 107 percent but other roundwood decreased by 56 percent.
- A decrease in the number of active sawmills from 117 in 1960 to 85 in 1962 was largely at the expense of small mills. Average annual production per mill increased from 1.9 million in 1960 to 2.9 million in 1962.
- Ponderosa pine continued its traditional lead as the principal lumber species in 1962 and accounted for 54 percent of the cut.
- Catron County was the only county that had a saw log cut of more than 50 million board feet in 1962.

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[2] *In this report board-foot volume in saw logs and sawtimber trees is based on International ¼-inch log rule. Lumber volume is based on lumber tally.*

[3] *The following are considered Mountain States in this report: Montana, Idaho, Nevada, Utah, Wyoming, Colorado, Arizona, and New Mexico.*

Forest Use, Past and Present

Forests grow on 18.2 million acres, or nearly one-fourth of the lands in New Mexico. The forested area—high plateaus, mesas, and mountain ranges—occurs usually above 4,500 feet in elevation. The greater amount of rainfall at these elevations than elsewhere in the generally arid to semiarid State of New Mexico is the principal reason that these lands are forested and are outstanding in variety of values and uses.

Forest resources have played a very important role in New Mexico's development. The forest range has a particularly long history of use. Progeny of cattle, sheep, and horses brought in by Coronado in 1540 have grazed forested lands throughout succeeding centuries. Water from the high forested country stimulated agricultural settlement to begin with and has subsequently made it possible to irrigate almost 1 million acres of cropland. Timber harvesting has increased from the small amounts used for fuel and construction by settlers to nearly ¼-billion board feet a year. Hunting and fishing, which originally provided important sources of food, are now significant reasons for the booming development of outdoor recreation.

Forests can contribute much more to the future development of the State. In general, demands for forest resources are increasing rapidly along with the country's mounting population. An inevitable result is that forest management problems are increasing, especially on the nearly 70 percent of the forest land that is publicly owned. On these public lands the need for increasing yields of timber, water, and forage as well as recreation facilities within a fairly fixed area creates complex problems in multiple use management. Before going into future needs and problems, the next few sections describe past development and the current situation.

Lumber is the principal timber product

New Mexico has 6.3 million acres of commercial forest. These lands, which comprise about one-third of the total forest area of the State, are capable of growing crops of industrial wood and have not been reserved for other uses. In 1963, more than 2,200 people (almost one out of every seven manufacturing workers in the State) were employed in logging operations, or in sawmills, planing mills, millwork plants, wood preserving concerns, and similar primary wood conversion industries. Total employment in these industries was second only to that in food processing among all manufacturing industries[1] in New Mexico.

The preponderance of the volume of timber products cut in the State comes from public lands. National Forest, Indian, Bureau of Land Management, and State lands comprise 69 percent of the commercial forest area. These provided 64 percent of the 46 million cubic feet of products harvested in New Mexico in 1962. A report by Wilson (1964) on the yield of timber products in New Mexico in 1962 shows the following distribution of harvest by land ownership classes:

	Percent
National Forest	**43**
Other public	**21**
Private	**36**

Lumber has been New Mexico's principal timber product for a great many years. In 1962, saw logs cut for lumber accounted for 78 percent of the cubic volume of timber products harvested in the State as reflected by the following tabulation:

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[1] *Industry classifications are those in the Standard Industrial Classification (SIC) of the U.S. Bureau of the Census. Timber industries included above all fall within SIC Code 24.*

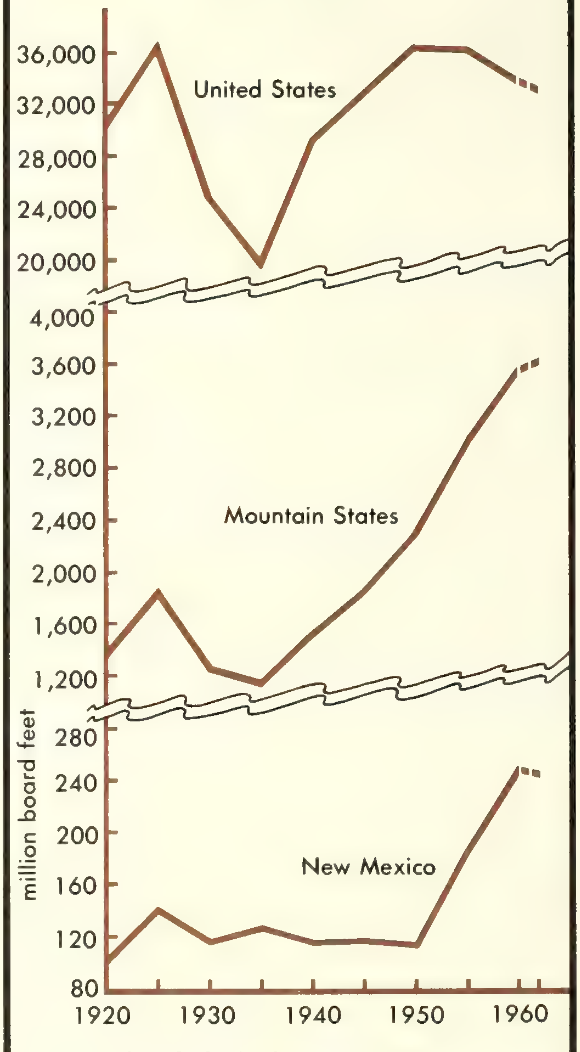
	Volume harvested, 1962 *(Thousand cubic feet)*
Saw logs	**35,905**
Posts, fuelwood, misc. farm timbers	**9,820**
Mine timbers (round)	**410**
Misc. industrial wood	**91**
Poles	**33**
Total	**46,259**

Lumber production in New Mexico increased sharply after 1949 (see chart at right). The 1962 output of 245 million board feet (lumber tally) was little different from the average for the period 1958 to 1962. Between 1920 and 1960, New Mexico's lumber output increased about 2.4 times—thereby keeping pace with the average increase for the Mountain States and far exceeding the slight rise for the United States.

Almost three-quarters of the lumber sawn in the State since 1869 has been ponderosa pine; it is more abundant and generally more accessible than any other species in the commercial forest. However, the percentage has gradually decreased over the years and the estimated 134 million board feet of ponderosa pine saw logs cut for lumber in 1962 amounted to only 54 percent of the total of all species. The chart on page 4 shows changes among species for the period 1946 to 1962. The saw log output by species in 1962 was as follows:

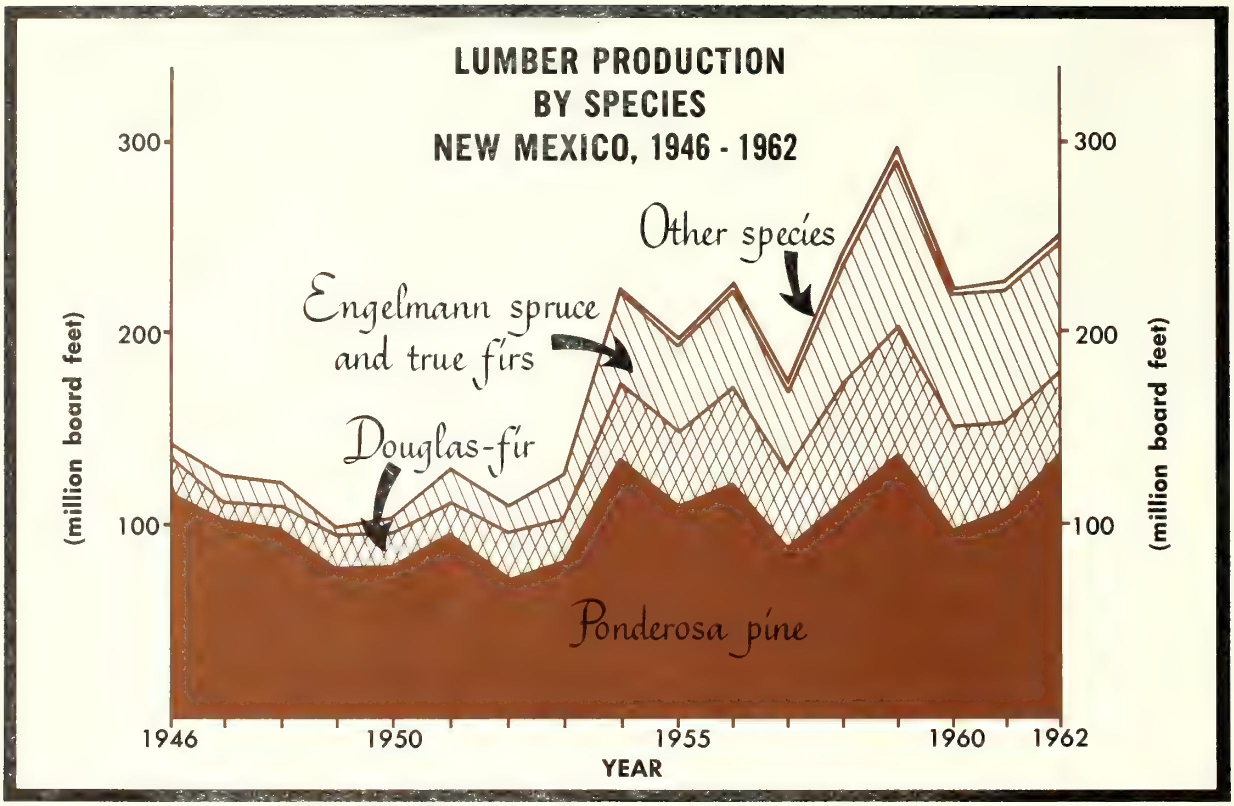
	Million board feet
Ponderosa pine	**133.7**
Engelmann spruce	**53.6**
Douglas-fir	**47.1**
True firs	**11.6**
Other species	**1.6**
Total	**247.6**

LUMBER PRODUCTION TRENDS 1920 - 1962[1]



[1] *Plotted on the basis of 5-year averages e.g. Average for years 1923-1927 plotted on 1925*

Sawmill of Navajo Forest Products Industries, Navajo. In this portion of the mill, boards are rough sorted and then moved by overhead crane (background) to be machine stacked and stickered before entering dry kilns. Built by Navajo tribal funds at a cost of about $6.5 million, this mill is one of the most modern in the industry. It includes two double cut band saws capable of producing 100,000 board feet per shift. Logs come mainly from reservation lands in New Mexico and Arizona, which have an allowable cut of 38.6 million board feet a year.



NEW MEXICO SAWMILLS AND SAW LOG PRODUCTION 1962

● Sawmill reported as operating in 1962[1]

★ City

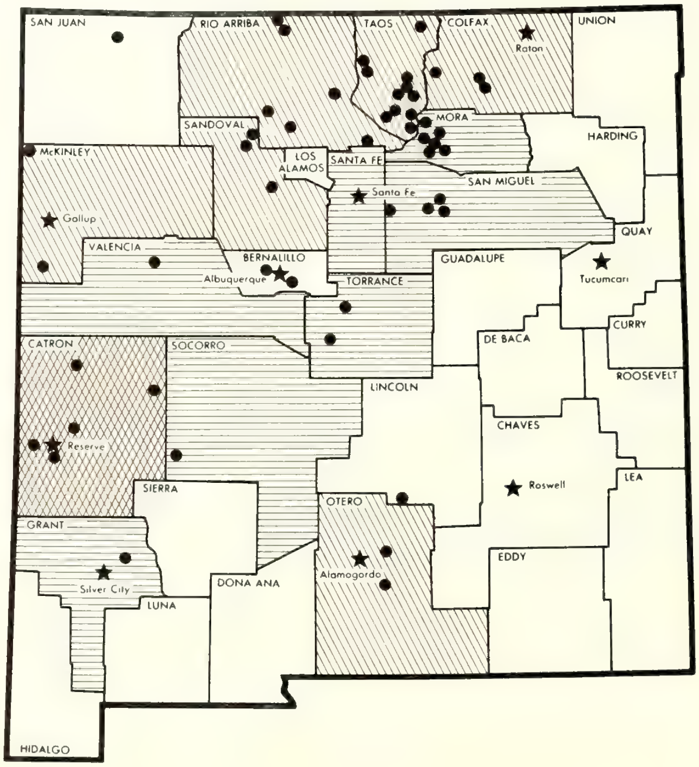
Saw log output by counties (million board feet)

☐ No reported production

▤ Less than 10

▨ 10 to 50

▩ 50 to 100



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[1] In addition to the mills shown, there were active mills that either did not furnish a report in the 1962 timber products survey, or whose report did not contain adequate information for locating on the map.

Sawmills come and go

Sawmilling is by far the biggest timber industry in New Mexico. In 1962, there were 85 sawmills operating, while there were less than 25 enterprises engaged in harvesting or processing materials such as converter poles, building logs, round mine timbers, posts, poles, and fuelwood.

The map on the facing page shows the location of sawmills that reported production in the 1962 forest products survey. It also shows saw log output by counties, of which only Catron had a production of more than 50 million board feet.

Instability is a characteristic of New Mexico's sawmill industry. Between 1889 and 1947, the number of mills increased gradually from 24 to 162, although there were many sharp fluctuations in the general trend. Since 1947, the trend has been reversed. Here again, there have been ups and downs as indicated by data available for these years:

	Active sawmills
1948	**120**
1954	**88**
1958	**70**
1960	**117**
1962	**85**

Distribution of mills by size class in 1962 was as follows:

Size class[1] *(Thousand board feet per year)*	**Active mills**
Less than 50	**12**
50 to 199	**16**
200 to 499	**10**
500 to 999	**16**
1,000 to 4,999	**19**
5,000 and over	**12**
Total	**85**

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[1] *Mill size class estimated from reported saw log receipts rather than lumber production.*

During the decline from 117 mills in 1960 to 85 in 1962, dropouts were particularly numerous among smaller size mills. This has been a general trend throughout the Mountain States in recent years. Fewer but larger and more efficient mills, together with a generally rising timber demand, have resulted in substantially greater average production per mill. In recent years, this increase has been 22 percent a year in New Mexico and 11 percent in the Mountain States as a whole.

Tractor skidding ponderosa pine logs on a New Mexico Timber Company operation, Santa Fe National Forest.

Timber cut volume and product values are low

In several ways, New Mexico is representative of the general or average level of timber harvesting in the Rocky Mountain States. In 1962, New Mexico cut 0.60 percent of its inventory of sound live trees. This is well above the 0.22 percent for the lowest State (Utah) and substantially less than the 1.08 percent for the highest (Arizona). The following figures permit comparisons with averages for the Rocky Mountain States and the country:

	Percent of cubic volume inventory cut, 1962
New Mexico	**0.60**
Mountain States	**.69**
United States	**1.61**

The situation is about the same when sawtimber cut is considered in relation to sawtimber inventory.

Economic considerations that hinder more timber harvesting are also much the same in New Mexico as in the Rocky Mountain area as a whole. A number of factors make production costs high in relation to product values. Access roads are expensive to build in the rugged terrain typical of much of the best timberland. Frequently, it is impossible to build roads that will not impair watershed values or cause erosion and still leave the operator a margin for profit and risk if construction costs must be borne by the timber alone. These costs could be borne if timber volumes were greater and quality better. However, compared to such areas as the west coast, volumes per acre are lower, logs are smaller and of poorer quality, and stands are less extensive in area. These natural disadvantages pose difficult problems as New Mexico seeks to expand markets for its wood products outside as well as within the State. An economic study of New Mexico timber industries (Long 1965) showed that in 1962 New Mexico exported 138 million board feet to other States and imported 137 million board feet of lumber, as well as 33 million square feet of plywood.

Data on value added to timber in harvesting and further processing provide a basis for certain economic comparisons. In 1962, New Mexico's timber industries added a value of $265 per thousand cubic feet of roundwood products harvested. This compares with $360 for the Mountain States as a whole. New Mexico, unlike Idaho, Montana, and Arizona—the leading timber-processing States in the Rocky Mountain area—does not have any plants that produce high-value products such as plywood, pulp, and paper. These industries, together with the opportunities they provide for integrated and efficient production processes, are a substantial benefit to the economy. However, as discussed later in this report, there are opportunities for such industries in New Mexico.

Forest lands are the principal source of water

None of the many values of New Mexico's forest area is more vital than that of water. The yield of surface water from the 36 percent of the area of the State that is in forests and intermingled openings within the elevational range at which trees grow constitutes almost 60 percent of the 2.7 million acre-feet of runoff from all lands.

Most of the streams that drain New Mexico's forests are headwaters of three of the country's major rivers—Colorado, Rio Grande, and Mississippi. However, some streams drain into a number of closed basins that do not discharge into these three rivers.

All of the significant streams are subject to interstate water compacts.

A recent report (Hale et al. 1965), which shows that water outflow from the State is about 23 percent greater than inflow, indicates that New Mexico is not using all of its water. When fully developed within limits of interstate compacts, outflow from the State will approximately equal deliveries into the State under the compacts (State of New Mexico 1959).

Demands for more water from forests and other lands probably will come mainly from municipal and industrial users. These users now account for only about 2 percent of the surface water consumed in various human activities but are expected to increase sharply along with the State's population which is expected to double by 2000.

Opportunities exist for substantially increasing the runoff from forest lands. Research in a number of places, including studies in the Southwest, show that the volume and timing of runoff can be improved by manipulating the kind and amount of tree cover. However, the extent that this can be done economically in relation to other values of the land will have to be carefully evaluated for each local situation.

Forage and wildlife uses are very important

The forest range has a long history of heavy use for livestock and big game forage. Overuse has occurred on much of the ponderosa pine, pinyon-juniper and other forested ranges, particularly during the livestock boom in the early 1880's. The number of cattle in New Mexico increased from 158,000 in 1870 to 545,000 in 1880 and to 1,065,000 in 1886. During the peak year for sheep —1882—about 5.2 million head grazed New Mexico ranges. Depletion of the range during these years, combined with blizzards and droughts, resulted in a collapse of the boom. One of the most important consequences of this period of overuse was a damaged range depleted forage—and a deteriorated soil mantle. Damaged range-

Sheep grazing in openings within the Carson National Forest. In 1963, 58,000 sheep and 85,000 cattle grazed under permit on the National Forests in New Mexico.

lands do not recover rapidly under climatic conditions that prevail in the Southwest, and many areas still bear scars of early misuse.

Establishment of National Forests in New Mexico, beginning in 1899, was an important step in bringing extensive areas of forest range under controlled use. However, it was not until after demands for livestock products eased following World War I that substantial improvement could be made in range use in relation to capacity. Between 1917 and 1963, the number of head of cattle that grazed on National Forests in New Mexico declined by 56 percent, and the number of sheep declined by 89 percent.

Range management has gradually improved over the last few decades. Today public land management agencies and many private interests have active programs that involve range inventories, revegetation, control of undesirable plants, deferred and rotation grazing, seasonal use, and such structural improvements as fences and water developments. On the National Forests, in 1964 for example, these were accomplished as follows: revegetation through seeding, 6,354 acres; plant control, 9,650 acres; erosion control, 1,005 acres; and fencing, 330 miles. Some of this work was done in cooperation with grazing permit holders.

Many species of wildlife are also important users of forest lands. There is no evidence that buffalo, deer, and other big game species, the original users of the forest range, had any important effect in depleting the range. However, subsequent use of forest lands for livestock, timber, and recreation, together with accelerating demands for hunting, have made it necessary to improve habitat conditions. Programs of public land management agencies, some in cooperation with the New Mexico Department of Game and Fish, include seeding to forage species, control of noxious plants, creation of wildlife openings, and development of water sources.

Recreation use has increased very rapidly in recent years

Among the various uses of New Mexico's forest lands, recreation has experienced the most spectacular gains since World War II. There are also indications that recreation traffic in New Mexico's forests has multiplied more rapidly during these years than in most parts of the country. Although comprehensive statistics are not available to show recreation use of all forest lands, estimates of the number of visits by recreationists to National Forests do permit certain comparisons among States.

The nearly 5 million visits made to National Forests in New Mexico during 1963 for camping, hunting, skiing, and many other activities amounted to 14.7 times the number of visits recorded for 1946. In this respect, New Mexico was exceeded among the Mountain States only by Arizona for which the number of visits in 1963 was 15.6 times that for 1946. Recreation traffic on New Mexico's forests increased many times more than the averages for the Mountain States or the nation as a whole.

	Number of recreation visits		*Number of times increase*
	1946	**1963**	
	(Thousands)		
New Mexico	**336**	**4,940**	**14.7**
Mountain States	**6,293**	**49,777**	**7.9**
United States	**18,241**	**122,582**	**6.7**

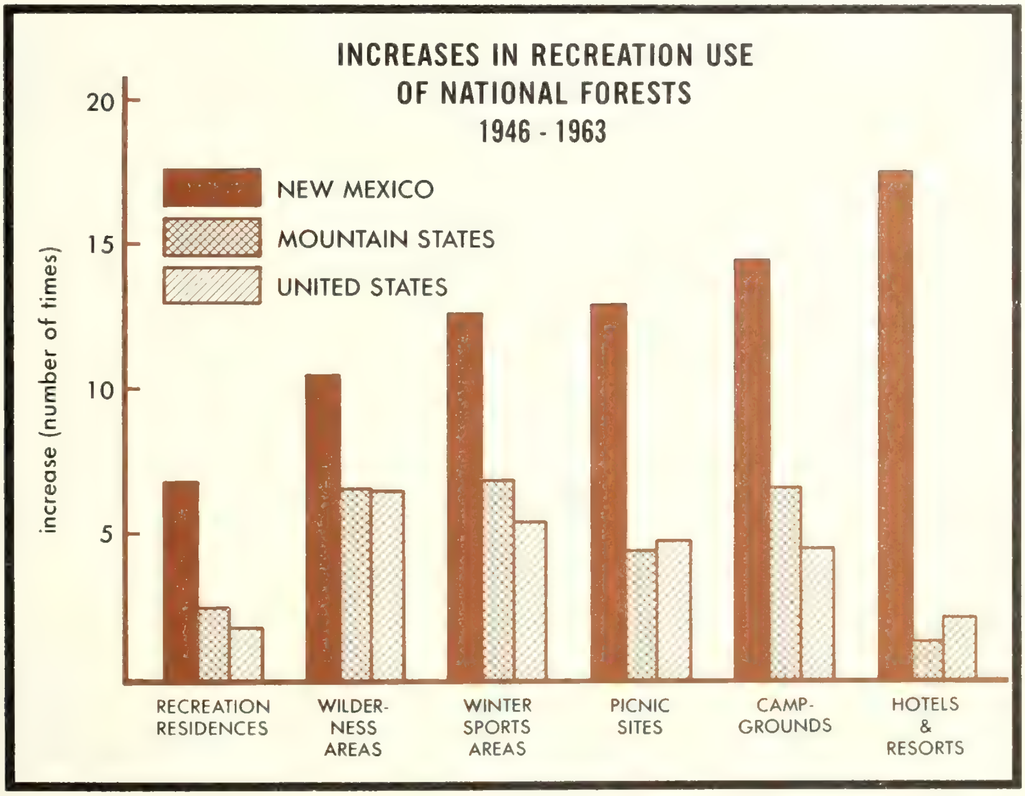
Many factors contribute to the boom in forest recreation in New Mexico. Here, as in other parts of the country, participation in outdoor recreation has roughly paralleled the rise in amount of leisure time, disposable income, and mobility of vacationers. There are other considerations that particularly favor New Mexico and the Southwest in general. New Mexico's population increase of 40 percent between 1950 and 1960, although only slightly higher than for the Mountain States as a whole (35 percent), was more than double the percentage of the nation as a whole. One reason for this might be New Mexico's climate which is conducive to year-round outdoor activity.

The chart below reflects the increasingly important role that New Mexico is assuming in meeting today's growing demand for outdoor recreation. Note the particularly big increase in visits to hotels and resorts in New Mexico as compared to other parts of the nation. Possibly this is because of greater opportunity for year-round occupancy in New Mexico.

Skiing is one of the most rapidly developing recreational uses of New Mexico's forest lands. Attendance at ski resorts has increased much more rapidly in New Mexico since 1955 than in any other western State. This is indicated by results of a recent comprehensive study of ski business in the west,[5] which shows that for the period 1955 to 1964 attendance at ski areas in New Mexico increased at an annual compound rate of 31 percent. This is about twice the average rate for the Western States.

Hunting and fishing uses have also shown relatively sharp upward trends in New Mexico. Increases on National Forests in New Mexico are well above the average for the Mountain States as a whole (see chart page 11).

The surge in recreation use in the postwar years has had a substantial impact on forest resource management. This is particularly the case on public lands. Except for the relatively small forested area within National Parks and Monuments where management is directed towards maintaining scenic and historical values, practically all public lands are managed on a multiple use basis. The U.S. Forest Service, for example, is currently examining National Forest lands, acre by acre, and prescribing management practices; such characteristics as soils,



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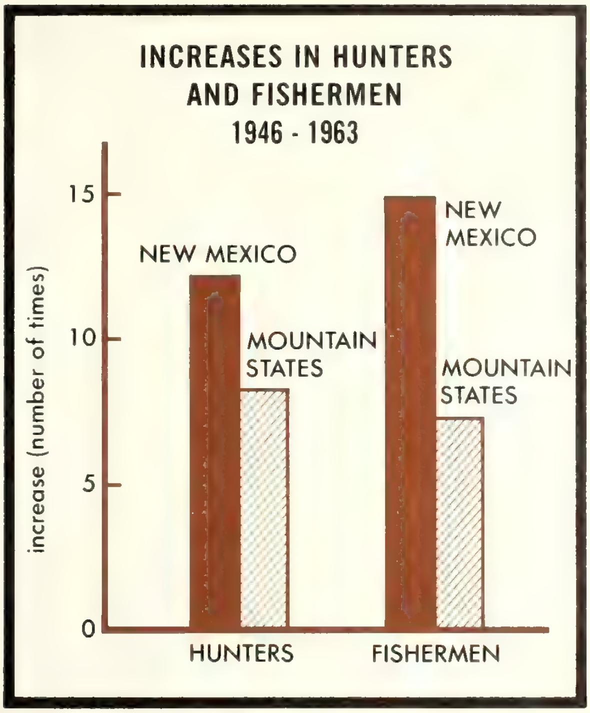
[5] *The study was conducted by the U.S. Forest Service at the request of the Economic Development Administration. A report is in process.*

Dwellings in the resort town of Cloudcroft within the Lincoln National Forest. The rapid increase in recent years in the number of residences and resorts situated in the forest and used primarily by recreationists for year-round activities is a significant development. Such active and growing communities as Cloudcroft and Ruidoso not only provide respite from the summer heat of southern New Mexico and west Texas but also permit a wide range of activities — picnicking, camping, fishing, horseback riding, etc. Winter and fall activities include skiing and hunting. These various pursuits provide big opportunities for private enterprises catering to recreationists. Many of the dwellings and resorts are located on private lands; others are built under permit or concession on public lands.



terrain configuration, drainage, and vegetation are considered as they relate to anticipated demands for water, timber, recreation, forage, and wildlife.

Efficient management also requires coordination among public agencies. For example, the New Mexico Department of Game and Fish is responsible for management and protection of wildlife, while public land agencies are concerned with maintaining and improving habitat. Close cooperation is needed to assure sustained yields of game and fish.

Elk foraging in ponderosa pine forest on the Santa Fe National Forest. Big game hunting — principally for deer, elk, and black bear — is one of the most important recreational uses of forest land. Photo courtesy of New Mexico Department of Development.

The Forest Today

New Mexico's 18.2 million acres of forests grow on the highlands, roughly within the elevation range of 4,500 to 12,000 feet above sea level. The amount of water that falls on these lands each year varies with elevation from about 12 inches at the lower limit of the forest to 35 inches at the higher. Vegetation at elevations below the forest is largely grasses, sagebrush, and desert shrubs; above the forest it is alpine sedges, grasses, and herbs.

Within the broad band of forest there is a general zonation of tree species in relation to elevation. However, considerable variation is found because of climatic and physiographic influences such as direction and steepness of slope, soils, etc. (photo on facing page). In general, however, the principal types occur as follows:

Type	Characteristic trees	Elevation *(Feet)*
Fir-spruce	**Engelmann spruce** **Subalpine fir** **Corkbark fir** **Limber pine**	**8,500-12,000**
Douglas-fir	**Douglas-fir** **White fir** **Aspen**[1] **Ponderosa pine** **Limber pine**	**8,000-9,500**
Ponderosa pine	**Ponderosa pine** **Arizona pine**	**5,500-8,500**
Pinyon-juniper	**Pinyon** **Juniper species**	**4,500-7,500**
Oak brush and woodland[2]	**Oak species**	**3,600-4,800**

The geographic locations of the timber types are shown by the map in the Appendix.

Only 6.3 million acres, or roughly one-third of the forest area, support timber of commercial importance. The remainder is designated noncommercial. Before discussing the commercial forest — the principal concern of this report — the following section briefly describes the noncommercial forest.

Noncommercial forests cover 15 percent of New Mexico

Although of little importance for timber production, the 12 million acres of noncommercial forest are valuable for a combination of other uses. A major portion of the area provides forage for livestock and game. While water yields are less per acre on the average than from the commercial forest, they provide a significant source of supply for people in the semiarid lowlands. About 964,000 acres are reserved primarily for recreation. These include National Parks and Monuments as well as wild, wilderness, and primitive areas within National Forests. Actually, about 561,000 acres of this reserved land are productive and would be considered commercial forest were they not set aside for other uses. The following tabulation shows the total acres for various classes of noncommercial forest:

	Thousand acres
Reserved-productive	**561**
Reserved-unproductive	**403**
Unreserved-unproductive	**10,954**
Total	**11,918**

Almost nine-tenths of the total noncommercial forest is pinyon-juniper lands that are found at the lower elevations of the

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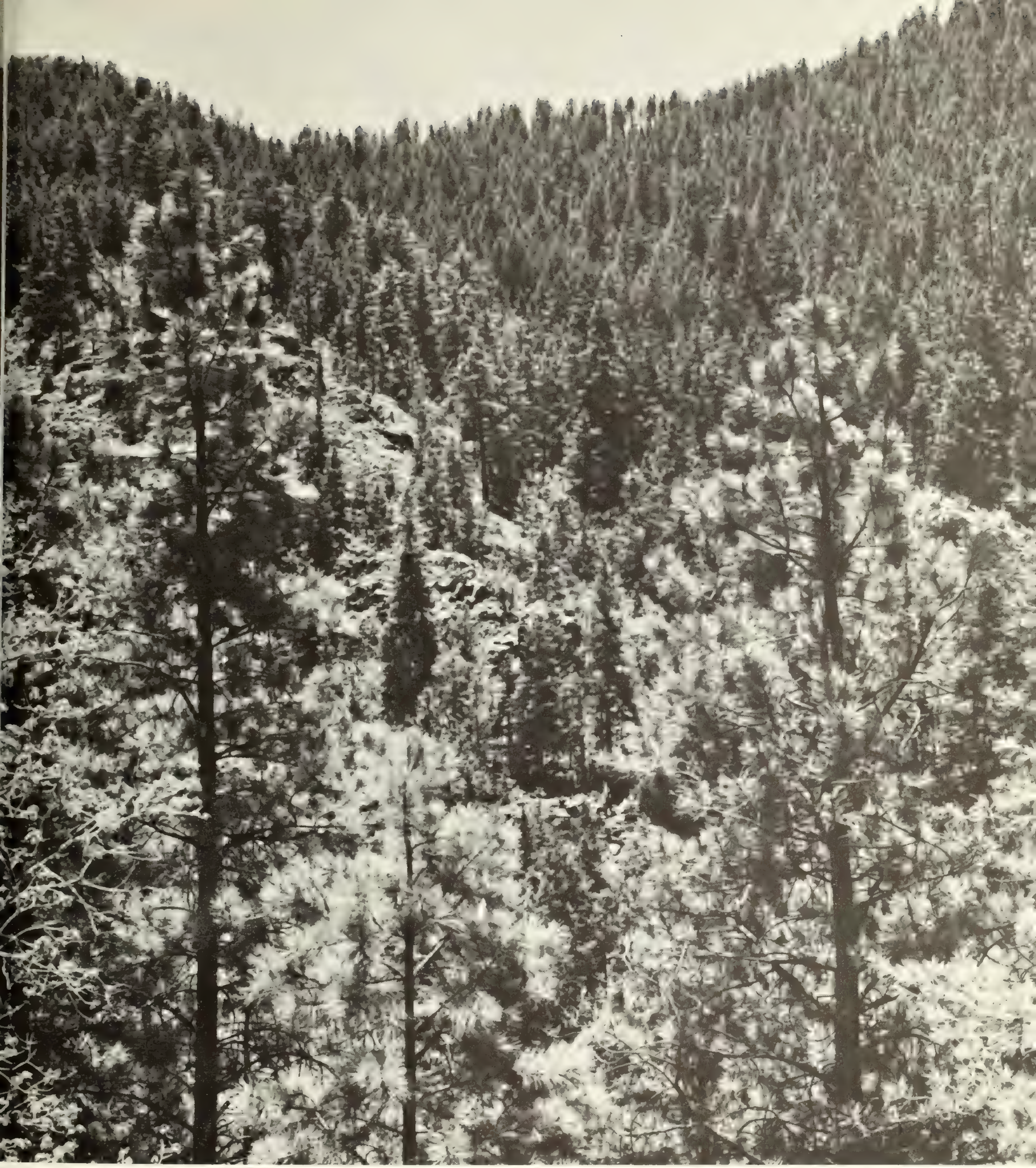
[1] *Where aspen predominates, it is recognized by Forest Survey as a separate type.*

[2] *Oak brush and woodland are classed by Forest Survey in the general category known as chaparral. Such lands are so designated in the statistical tables and generalized type map in the Appendix.*



Stand of Douglas-fir (background) on a north-facing slope and ponderosa pine (foreground) on a hotter and drier south-facing slope. This photo, taken just east of Mogollon in the Gila National Forest at an elevation of about 8,500 feet, illustrates the difference that can occur in type of tree cover in relation to direction of slope.

Photo on the facing page shows noncommercial forest in Frijoles Canyon, Bandelier National Monument. This reserved area includes both productive lands (such as the ponderosa pine stand in the center of the photo) and unproductive lands (the pinyon-juniper hillside). In the small clearing are ruins of a Pueblo Indian dwelling called "Rainbow Room," which was constructed in the period 1200 to 1537 A.D.

Photo to the right, taken near Los Alamos, illustrates pinyon-juniper lands. Improved fire protection has resulted in the invasion of pinyon and juniper trees into many areas of grassland. This has generally meant a deterioration of forage production on such lands. However, extensive areas have been cleared of pinyon and juniper in recent years and sowed with forage grasses for livestock and game.

forest. Another 5 percent is oak brush which also grows at low elevations. The remaining 5 percent consists of areas of ponderosa pine, fir-spruce, and other types that grow where soils or climate are unfavorable—either as patches within the predominantly commercial forest zone, or as the upper fringe of the forest; i.e., just below timberline.

The 10.6 million acres of pinyon-juniper type in New Mexico support a big volume of wood—about 1.7 billion cubic feet of which roughly one-half is pinyon and one-half juniper. Despite this large volume, only a small percentage is harvested for posts, fuelwood, and charcoal—the principal wood products. Pinyon is gaining popularity as a Christmas tree and in 1963 accounted for roughly 15 percent of the estimated cut of 350,000 Christmas trees in the State.

The extent to which pinyon-juniper lands can be made more productive is a very important consideration in the management of New Mexico's wildlands. Probably the greatest opportunities lie in improving the land for forage, although some areas may be suitable for agricultural crops. Where these are the objectives, eradication of pinyon and juniper trees will usually be necessary because of their inhibiting effect on desirable vegetation. Many areas have already been cleared and improved. Reliable estimates of additional acreage on which improvement is justifiable are not possible without detailed surveys of potential land use.

Sawtimber stands predominate in the commercial forest and run heavily to old growth

New Mexico's 6.3 million acres of commercial forest support a timber stand of 6.6 billion cubic feet in sound live trees 5 inches and larger in diameter at breast height (d.b.h.). Sawtimber trees have a volume of 28.3 billion board feet of which 98 percent is in sawtimber stands.

New Mexico has a relatively high proportion of commercial forest in sawtimber stands (87 percent) as compared to the Mountain States as a whole (59 percent). However, volume per acre in sawtimber stands (5,072 board feet) is the lowest of any of the Mountain States and is not much more than one-half the Mountain States' average (9,957).

Forty-six percent of New Mexico's 27 billion board feet of softwoods is in trees 19 inches and larger. However, there are substantial differences among species:

	Percent of sawtimber volume in trees 19.0 inches and larger
Ponderosa pine	**54**
Douglas-fir	**42**
True firs	**32**
Engelmann spruce	**26**

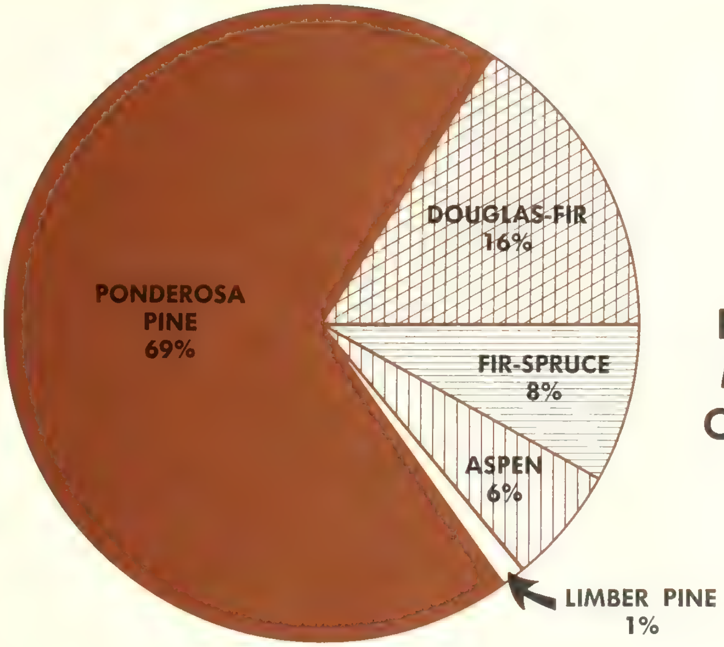
About 47 percent of the commercial area is occupied by old-growth stands; i.e., stands in which the dominant trees are more than 120 years old. Private lands, being more accessible, have proportionately less old growth (37 percent) than public lands (52 percent).

Poletimber, seedling, and sapling stands account for slightly less than 10 percent of the commercial area. The nonstocked area (220,000 acres) is only 3.5 percent of the total.

Although there is a relatively small area of poletimber, sapling, and seedling size classes, this does not mean that reproduction is lacking. Many present stands have trees of several age classes and of all sizes. About one-eighth of the cubic-foot volume of sound live trees in sawtimber stands is actually in trees of pole size. Although most ponderosa pine stands consist of trees of several age classes at the present time, the objective on National Forests is to convert the forest gradually to even-aged stands.

Ponderosa pine is the principal timber species

Very few States in the country have as high a percentage of commercial timber area and volume in one species as New Mexico has. Almost three-fifths of the State's volume of sound live trees is ponderosa pine. Ponderosa pine is the predominate species on more than two-thirds of the commercial lands. The other commercial species that occur most frequently are Douglas-fir, Engelmann spruce, true firs (subalpine, corkbark, and white), aspen, and limber pine. These species occur in five timber types recognized by Forest Survey—ponderosa pine, Douglas-fir, fir-spruce, aspen, and limber pine. The charts at right indicate the relative importance of the species and types. Most of the important species are illustrated by photos and described on the following pages. Limber pine is one of the species not illustrated. Although of minor importance for timber production, limber pine is significant for watershed protection. It grows in small and scattered patches at high elevations—on 43,000 acres as a type, and elsewhere as individual trees in the fir-spruce and Douglas-fir types. Because it usually grows on poor sites—thin-soiled and exposed to high winds—trees are generally short and of poor form. Although the inventory shows a volume of 640 million board feet, little is cut each year.

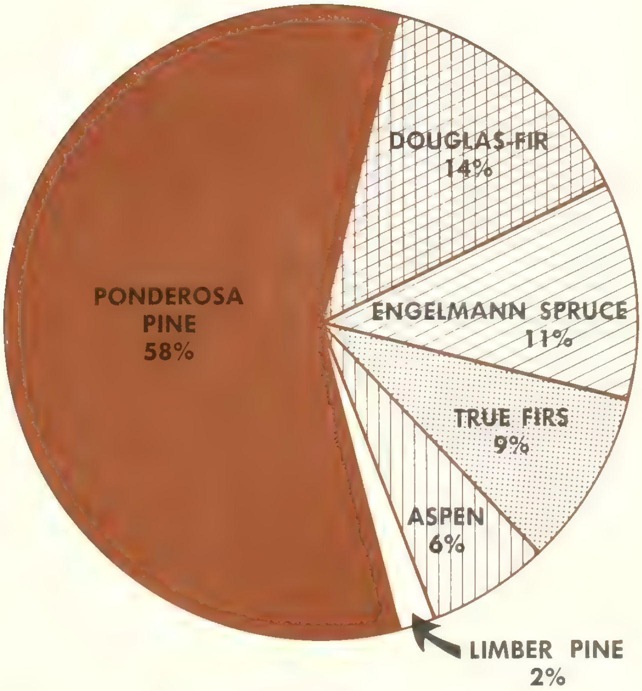


AREA BY TYPE

PERCENT OF 6.3
MILLION ACRES
OF COMMERCIAL
FOREST

VOLUME BY SPECIES

PERCENT OF 6,616
MILLION CUBIC FEET
IN SOUND LIVE TREES



Ponderosa Pine Forests

Shown at left is a ponderosa pine stand. This stand, which is in Jemez Canyon on the Santa Fe National Forest, remains after a partial cut made some years ago. The site is better than the average for ponderosa pine in New Mexico. The large trees are mature, 20 to 22 inches d.b.h., and about 120 feet tall.

Stands such as this, supporting few sawtimber trees but many poles, seedlings, and saplings, are among the 3.9 million acres of sawtimber that comprise 90 percent of the commercial area of ponderosa pine. The remaining area is poletimber (4 percent), seedling-sapling (2 percent), and nonstocked (4 percent).

Ponderosa pine has always been the mainstay of the timber industry in New Mexico. Large-scale use began after construction of the first railroads, and between 1878 and 1881 ponderosa pine forests near Las Vegas, Pecos, and Santa Fe were heavily exploited for ties and construction materials. Versatility of ponderosa pine wood subsequently brought it into big demand for many other uses; i.e., poles, posts, mine timber, and — most of all — lumber. About 73 percent of the 7.5 billion board feet of lumber that has been cut since sawmilling began in New Mexico has been ponderosa pine. Although other species have gradually increased in relative importance (see graph page 4), ponderosa pine still accounted for 54 percent of the total lumber output for the State in 1962.

Early logging practice, whereby select trees were "highgraded" from most of the ponderosa pine stands, is a principal reason that top quality saw logs are scarce today. Less than 1 percent of the saw logs in the present forest can qualify as **select** (grade 1);[6] about 83 percent of the inventory is classed as **low common** (grade 4). However, as discussed later in this report, markets for low-grade sawtimber will be bolstered if such products as veneer and plywood can be produced economically.

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[6] *A system of four grades was used in the inventory on which this report is based. See Terminology in the Appendix.*

Douglas-Fir Forests

Shown at left is a Douglas-fir stand of large sawtimber. Mature and well-stocked with many trees 115 feet tall and 20-24 inches d.b.h., this stand is on the Santa Fe National Forest.

In New Mexico, Douglas-fir grows as a timber type on 1 million acres or 16 percent of the commercial forest area; in this respect it is second only to ponderosa pine. Douglas-fir seldom grows in pure stands. Within the general 8,000- to 9,500-foot elevational range of the species, it mixes with ponderosa pine at the lower end of the range and with true firs and spruce near the upper limits. White fir and aspen are common associates throughout the Douglas-fir type.

Ninety percent of the area of Douglas-fir type is classed as sawtimber. These stands almost always contain several age classes, which present good opportunities to organize into even-aged stands. They consist of overmature sawtimber trees with an understory of poles, saplings, and seedlings.

The area of the Douglas-fir type is tending to increase at the expense of other types. Many present stands of aspen and ponderosa pine have an understory of Douglas-fir and white fir that will eventually replace the overstory unless management practices or fire change the trend in succession.

Douglas-fir is suitable for many uses. Timber has been sawed into boards, dimension stock, sheathing, flooring, and railroad ties for many years. Prior to 1962 Douglas-fir was almost always second to ponderosa pine in volume sawed for lumber. However, in 1962 the cut of Douglas-fir (47 million board feet) fell to third place behind ponderosa pine and Engelmann spruce. Christmas tree production is another significant use of both Douglas-fir and white fir. The estimated 1963 harvest of these two species (about 245,000 trees) accounted for about 70 percent of all Christmas trees cut in the State.

Douglas-fir lands are found at high elevations at which temperatures are relatively cool. This makes them attractive as sites for summer homes, as well as for year-round outdoor recreation activities.

The most significant value of these lands, however, is undoubtedly water. Many of the Douglas-fir sites are steep, rocky slopes with thin soils where erosion control and watershed protection are paramount. A comparison of the mean annual precipitation of Douglas-fir lands (25 inches) with that of the State as a whole (15 inches) indicates their importance in terms of water runoff per acre.

Fir-Spruce Forests

Shown at left is a fir-spruce stand. Located on the Sandia Crest road at an elevation of about 9,500 feet, this is a medium site for spruce. It is an overmature stand with many sawtimber trees that are 18 inches d.b.h. and 85 feet tall.

Fir-spruce stands, which are found for the most part just below upper timberline, have a mixture of species. Engelmann spruce is the most important commercial tree, although subalpine firs are generally as numerous in the stand. Other species that occur less frequently include corkbark fir, white fir, and Douglas-fir, as well as limber and bristlecone pines.

About 85 percent of the area of the fir-spruce type consists of sawtimber stands, most of which are overmature. Young trees, such as seen in the photo, are usually present in these old stands. Most of the area that is not in sawtimber is stocked with poles or smaller trees; only a minor area is nonstocked.

Engelmann spruce and — to a lesser extent — true firs have been gaining significantly in importance for timber use (see chart p. 4). Although these species have contributed only about 11 percent of all lumber produced since lumbering began, they accounted for about 26 percent in 1962. For that year Engelmann spruce was second only to ponderosa pine.

Although the area of the fir-spruce type is relatively small (0.7 million acres of commercial and noncommercial combined), it is very important for water yields. These lands receive more precipitation per acre than any other class of forest, and water runoff is therefore high. Recreation values are also significant, particularly for wilderness travel; the 122,000 acres of productive reserved area of the type is practically all in wilderness, primitive, or wild areas in National Forest.

Aspen Forests

Shown at left is an aspen stand west of Los Alamos. Trees in this mature stand are of better than average quality. They average about 85 feet tall and 10 to 14 inches d.b.h. Sawtimber stands[7] make up almost one-half of the 367,000 acres of commercial aspen in the State. More than the other species found in the State, aspen grows almost entirely in single-aged stands, many of which originated after fires within the last 100 years. An understory of mixed conifers is common; the almost pure understory of ponderosa pine shown in this photo is somewhat exceptional.

Although little aspen is being harvested at present, the situation could change. This species is well suited for pulpwood, excelsior, core stock, and lumber for certain uses, and demand for such could well develop in New Mexico as has been the case in many other areas. Yet, there are some who argue in favor of converting aspen areas to Douglas-fir, white fir, and other species now in demand. They reason that many areas on which aspen is now found have a potential for greater yields of sawtimber if stocked with conifers.

However, conversion of most aspen stands to conifers would be undesirable from the standpoint of other resource values. The root sprouts, forbs, and other understory vegetation in aspen stands are excellent forage for big game and livestock. On well-managed lands aspen is considered as satisfactory as conifers from the standpoint of watershed protection. However, it is a better soil builder. The brilliant autumn foliage of aspen is one of the main scenic attractions of the forest.

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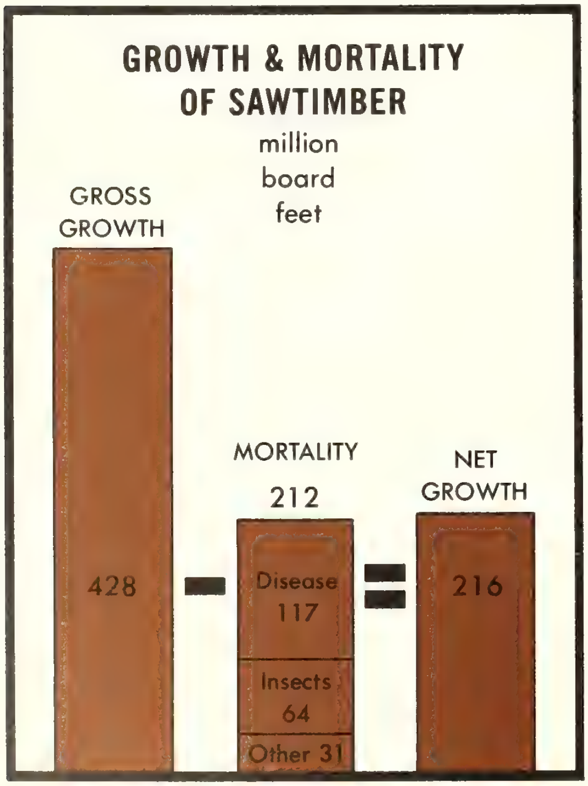
[7] *The minimum d.b.h. for aspen and other hardwood sawtimber is 11.0 inches; for softwood sawtimber it is 9.0 inches.*

The old-growth timber is susceptible to high mortality

The 212 million board feet in sawtimber trees that die each year in New Mexico's forests amounts to 0.75 percent of the sawtimber inventory (28.3 billion board feet). This mortality rate is somewhat less than that for the Mountain States as a whole (0.96 percent) and mortality volume is well below the gross growth of 428 million board feet.

Mortality rates vary substantially among species. It is particularly high in aspen, which has an annual mortality loss of 4.08 percent of sawtimber inventory—practically all caused by diseases and insects. Engelmann spruce and ponderosa pine are relatively low with rates of 0.10 and 0.25 percent, respectively.



Although roughly 23 million board feet of dead trees were salvaged in 1962 for saw logs and 8.3 million cubic feet for other products, there was still a big net loss of timber suitable for harvesting. More intensive harvesting and management, as discussed later in this report, would preclude much of the sawtimber mortality as well as some of the annual mortality in poletimber (11 million cubic feet).

The principal causes of mortality are diseases, insects, weather (mostly lightning and wind), and fire. The relative importance of these destructive agents can vary greatly from year to year. Only the effects of disease are fairly constant; the others can go up and down very rapidly. Pearson (1950) indicates that lightning and wind are the most widespread causes of mortality in ponderosa pine. However, Forest Survey records show that for the period 1958 to 1962, 55 percent of sawtimber mortality for all species was caused by diseases, 30 percent by insects, and the remaining 15 percent by weather, fire, and other factors.

Dwarfmistletoe is very widespread and undoubtedly causes a greater loss of growth than any other disease. A 1960 report (Andrews and Daniels) indicates that 40 percent of the ponderosa pine in New Mexico is infected, and that infection is especially heavy in virgin stands. It is also present in stands of Douglas-fir and other conifers. The inhibiting effect of dwarfmistletoe on growth is indicated by significantly less merchantable volume per acre and a higher incidence of mortality in the more heavily infected stands. In New Mexico, dwarfmistletoe is particularly abundant in the White Mountains and the Sacramento Mountains.

Of the other diseases, red rot, which is very common in old-growth ponderosa pine trees, is by far the most destructive at present. However, a species of root rot that has a potential for being the most destructive disease of all has been found in several places in the Southwest.

Insects also cause a big loss in timber volume in New Mexico's forests. Insect attacks usually fluctuate much more from year to year than disease, and are frequently of explosive proportions. For example, while bark beetles in ponderosa pine and true firs remain endemic over long periods, big outbreaks can occur when stands are in a weakened condition. This is what happened in 1956 following a prolonged drought. As a result, mortality from bark beetles reached an all-time high in 1957 when more than 600 million board feet of sawtimber was killed in the Southwest. Engelmann spruce, though less extensive in area than ponderosa pine, can also incur heavy and rapid mortality from epidemics of the Engelmann spruce beetle. This is especially likely to happen unless blowdown trees and debris from logging and road construction are either used or burned immediately.

The most significant insect infestations in 1964 were by spruce budworm on two large areas of mixed conifers—one of 350,000 acres near Chama and Cimarron, the other on about 130,000 acres of the Gila and Lincoln National Forests in southern New Mexico.

Lightning, blowdown, and fire are also very important causes of mortality. In 1962 these were the principal factors in the loss of about 31 million board feet of sawtimber. Big variations occur, however, from year to year because of differences in weather conditions. For example, fire statistics for the years 1958 to 1962 show an average annual burn of 11,804 acres of forest land, but for individual years the burn ranged from 4,762 acres in 1958 to 19,835 in 1962. Long-term statistics indicate a fairly steady increase in number of fires each year. Intensified fire control efforts, however, have tended to reduce the size of individual fires.

Timber yields can be substantially increased

The commercial forest of New Mexico is growing at the rate of only a little more than 8 cubic feet per acre per year. The annual yield potential of growing stock volume, even without harvest of thinnings, is much higher—about 38 cubic feet per acre. For the

Blowdown of Engelmann spruce. Windthrow is an important cause of mortality in old-growth stands of spruce and fir, such as this one at a high elevation on the Santa Fe National Forest. Down trees are choice host material for the Engelmann spruce beetle. Unless salvage and slash treatment action is prompt, catastrophic losses can occur in adjoining stands.

total 6.3 million acres of commercial forest in New Mexico, therefore, the potential yield is roughly estimated at 240 million cubic feet, which includes about 875 million board feet of sawtimber.

These figures do not take into account subordination or elimination of timber production in favor of such uses as watershed development and recreation. Greatly increased growth rates would also require a vigorous and prolonged program of stand improvement and other cultural effort. Nevertheless, these figures do indicate that New Mexico has a substantial untapped growth capacity, should the need arise.

Something like 31 percent of the commercial forest land in the United States has an annual growth potential of more than 85 cubic feet per acre. Less than one-half of 1 percent of the New Mexico forest land has such high production capacity. Reliable potential yield estimates are available only for the ponderosa pine type in New Mexico. The following tabulation compares the percent of commercial forest land within productivity classes of the ponderosa pine type in New Mexico with the average for all forest types in the country:

Productivity Class *(Cu. ft. per acre, per year)*	**New Mexico** *(Percent)*	**U.S.A.** *(Percent)*
120 or more	0.0	8.5
85-120	0.2	22.9
50-85	16.6	45.6
20-50	83.2	23.0

Site index, which is based on tree height in relation to age,[5] is another measure that is frequently used to estimate relative site quality for a species. The following tabulation indicates the distribution of ponderosa pine area by site index classes:

Site index class	*Percent*	**Site index class**	*Percent*
40	17	80	4
50	27	90	1
60	35	100	[1]
70	16	110	[1]

[1] *Less than 0.05 percent*

Although more data are needed from other States before precise comparisons are possible, undoubtedly site index for ponderosa pine is relatively low in New Mexico.

Ownership is largely in public and farm holdings

The ownership situation is one of the most important factors that bear on the economic development of forest lands in New Mexico. Here, as in the other Mountain States, the bulk of the forest area is managed by public agencies. Although 69 percent of the commercial forest land of New Mexico is publicly owned, this is less than the average for the Mountain States area (77 percent) and is also the lowest of any of the individual States except Nevada. The following tabulation shows the forest land ownership in New Mexico:

	All forest *(Thousand acres)*	**Commercial forest** *(Thousand acres)*
Public		
National Forest	7,267	3,458
Indian	2,885	617
Bureau of Land Management	1,429	77
Miscellaneous Federal	120	9
State	933	172
Total public	12,634	4,333
Private		
Farmer	5,074	1,557
Miscellaneous	479	379
Total private	5,553	1,936
All	18,187	6,269

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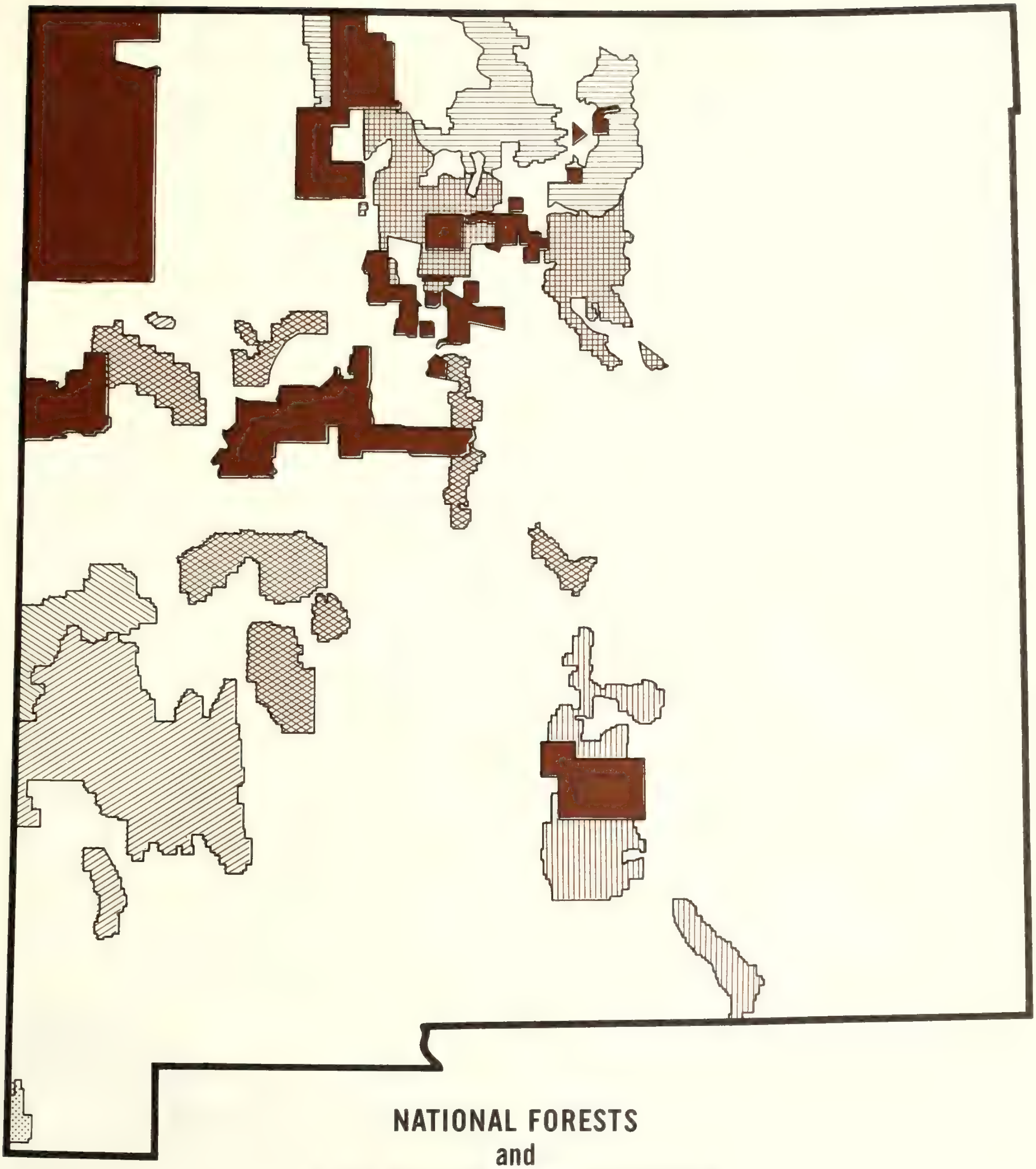
[5] *Site index is the height in feet of average dominant and codominant trees at specified age (100 years in the case of ponderosa pine). For example, site index 70 for ponderosa pine means that the dominant and codominant trees on the area referred to average, have averaged, or will average 70 feet in 100 years.*



NATIONAL FORESTS
and
LAND IN INDIAN RESERVATIONS

Land in Indian Reservations ■

National Forests, by name:

	Carson ▤	Coronado ░	Lincoln ▥
Apache ▧	Cibola ▩	Gila ▨	Santa Fe ▦

Almost three-fourths of the commercial sawtimber volume in the State is in public administration. The distribution of the total volume by class of owner is as follows:

	Million board feet
National Forest	**14,859**
Indian	**5,284**
Bureau of Land Management	**296**
Miscellaneous Federal	**45**
State	**618**
Private	**7,241**
Total	**28,343**

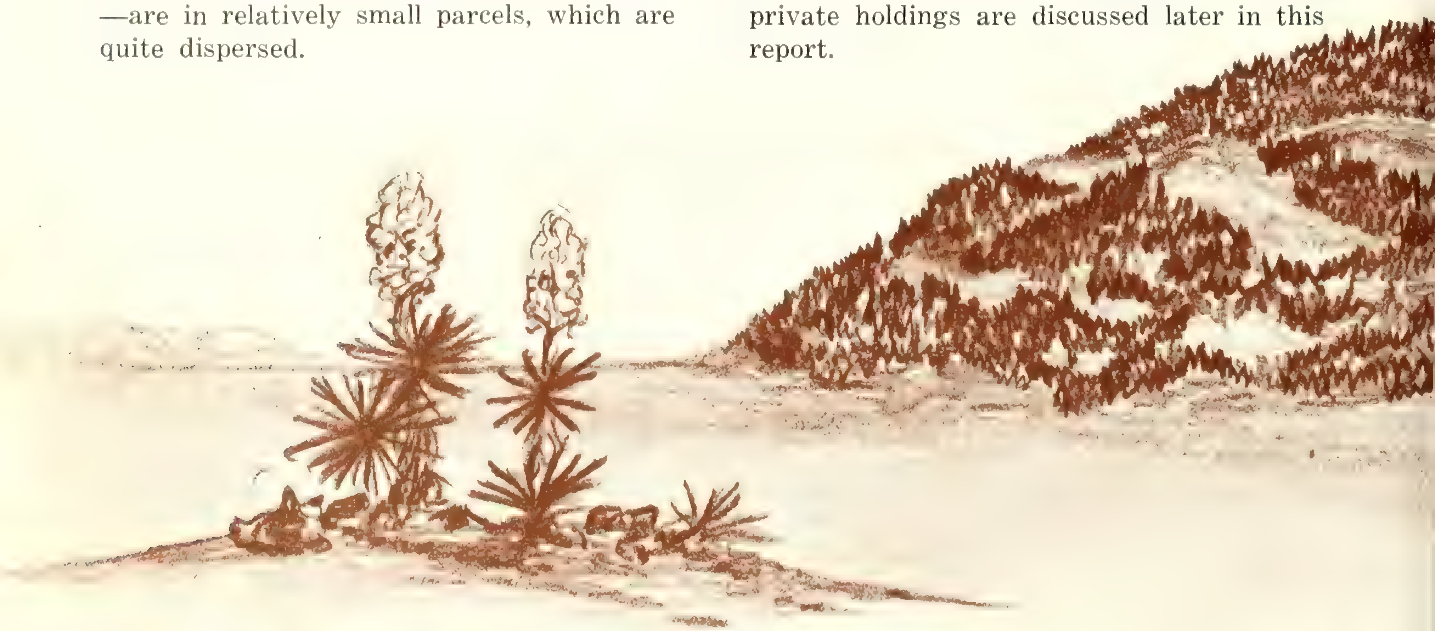
Ninety-four percent of the commercial forest area under public administration is found on Indian lands and the seven National Forests located wholly or partly within New Mexico. One of these National Forests, the Santa Fe, includes what was once the Pecos River Forest Reserve—one of the first areas in the country set aside for preservation of watershed and timber values.

The principal commercial forest areas on Indian lands are within the large reservations—Mescalero, Navajo, Jicarilla, United Pueblos, and Zuni. These lands, under Federal trusteeship, are managed under about the same policies as National Forests. The map on the previous page shows the area in Indian Reservations, as well as the National Forests. Other publicly administered commercial forest lands—principally Bureau of Land Management and State of New Mexico—are in relatively small parcels, which are quite dispersed.

There are substantial differences among principal species in the proportion of sawtimber volume that is in public ownership as reflected in the following tabulation:

	Percent in public
Ponderosa pine	**88**
True firs	**71**
Engelmann spruce	**62**
Douglas-fir	**59**
Aspen	**22**

Private holdings comprise 31 percent of the commercial area and are of several types: Some are in the big Spanish land grants in the northern part of the State; others are owned by forest industries; the bulk (80 percent of the area), however, is owned by farmers and ranchers. A 1953 survey (U.S. Forest Service 1958) showed that there were about 2,000 private owners of commercial forest and of these, 88 percent were farmers or ranchers. This percentage is twice that of the Mountain States area as a whole and is substantially higher than that of any of the individual States. The situation is probably about the same now as it was in 1953. Because of the State's high percentage of small owners, most of whom have little interest in forest management, New Mexico is especially handicapped in its timber resource. Some of the opportunities and problems with respect to management of small private holdings are discussed later in this report.



Management Problems and Opportunities

Timber supplies will support a bigger cut

Timber marketing in New Mexico is beset by the same problems encountered throughout the Rocky Mountains. A few of these problems are less serious than in other areas, but most of them are just as difficult to solve as elsewhere. These include: inadequate markets; a preponderance of old-growth timber that is risky to hold and expensive to protect; slow growth of trees; low volumes per acre and poor quality timber as compared with the west coast and other major producing areas; soils that are easily damaged; and difficult regeneration problems. Other adverse factors are an inadequate road system, a backlog of stand improvement work, and disinterest in timber management by most private owners with small holdings. The need for managing timber with regard to water, recreation, and other forest uses is still another problem—one that may well become the most important, and the most difficult to solve.

The previous description of timber supply and demand in New Mexico provides many indications that industry is not using nearly all the wood suitable for harvesting each year. One clue is that annual cut is merely 0.6 percent of inventory. While this is only slightly less than the cutting rate for the Mountain States as a whole, it is far below the 1.08 percent rate for Arizona where timber stands and the forest environment are not too different from those found in New Mexico. Another indication is the preponderance of old timber. Sawtimber stands occupy 87 percent of the commercial area, and most of the sawtimber trees in these stands are overmature and highly susceptible to diseases, insects, and other losses. Mortality is high.

Accelerated cutting of the old timber would have several results. In addition to whatever immediate benefits would accrue in the form of wages, profits, and taxes, timber management would gain by some alleviation of the problems connected with protecting old growth from catastrophic losses. However, future benefits could be even greater. A more rapid harvest of stagnant old growth, accompanied by a vigorous program of regeneration and cultural work, would result in a proportionate increase in the area of fast-growing young stands. This would enhance New Mexico's opportunity to share in meeting projected national demands for timber in the next century. By 2000, which is not far away in terms of the time it takes trees to mature, the demand for timber products in the United States is expected to increase by 81 percent. The market for pulpwood, plywood, and veneer probably will develop much more rapidly and will be about 2.7 times greater by 2000 than it was in 1962 (U.S. Forest Service 1965).

The extent that the cut can be increased depends not only on such factors as markets and progress in road development, but also on management objectives. The effect that management of the forest for water, recreation and so forth will have on timber yields in the future cannot be estimated with much confidence at this time. A much clearer picture will develop as results of current research become available and are applied in making intensive multiple use inventories.

Conservative estimates indicate that a substantial immediate increase in cut on public lands is highly desirable within the framework of sustained yield management for timber, as well as other uses. If markets and timber access are improved, a feasible annual cut would be two to three times the 40 million cubic feet cut in 1962. This would mean an annual cut of between 1.2 and 1.8 percent of inventory. Even the latter would provide a yield of only one-half the annual potential (about 240 million cubic feet).

The trend in timber yields over the next 30 or 40 years will depend not only on present stand conditions but on cutting practices and cultural treatment that are adopted during this period, as well as market demands. Good management, combined with a market for small roundwood as well as saw logs, should, in time, substantially increase the level of cut. The following sections describe some of the approaches to opportunities for enhancing timber use in New Mexico.

Access to timber is inadequate

It should be fairly obvious that before timberlands can be managed efficiently they must be accessible. Access is needed not only for timber harvesting but also for protection, planting, thinning, and other cultural work. Large areas, particularly of public lands, have remained untapped while many areas served by roads have tended to be overcut in the past. In other words, it has not been possible to manage some large timber properties as a whole but rather on a piecemeal basis.

A principal reason that many timberlands are not yet accessible for cutting is that timber values have been too low to bear the cost of roads and still return a profit to the logger. Factors that make these areas submarginal are low volumes per acre, patchiness of timber in some areas, low quality trees, and—in a great many places—very rugged terrain with erosive soils. Construction of roads that will not result in erosion and deterioration of the land for watershed and other values is of primary consideration. Such roads are costly because high construction standards must be established.

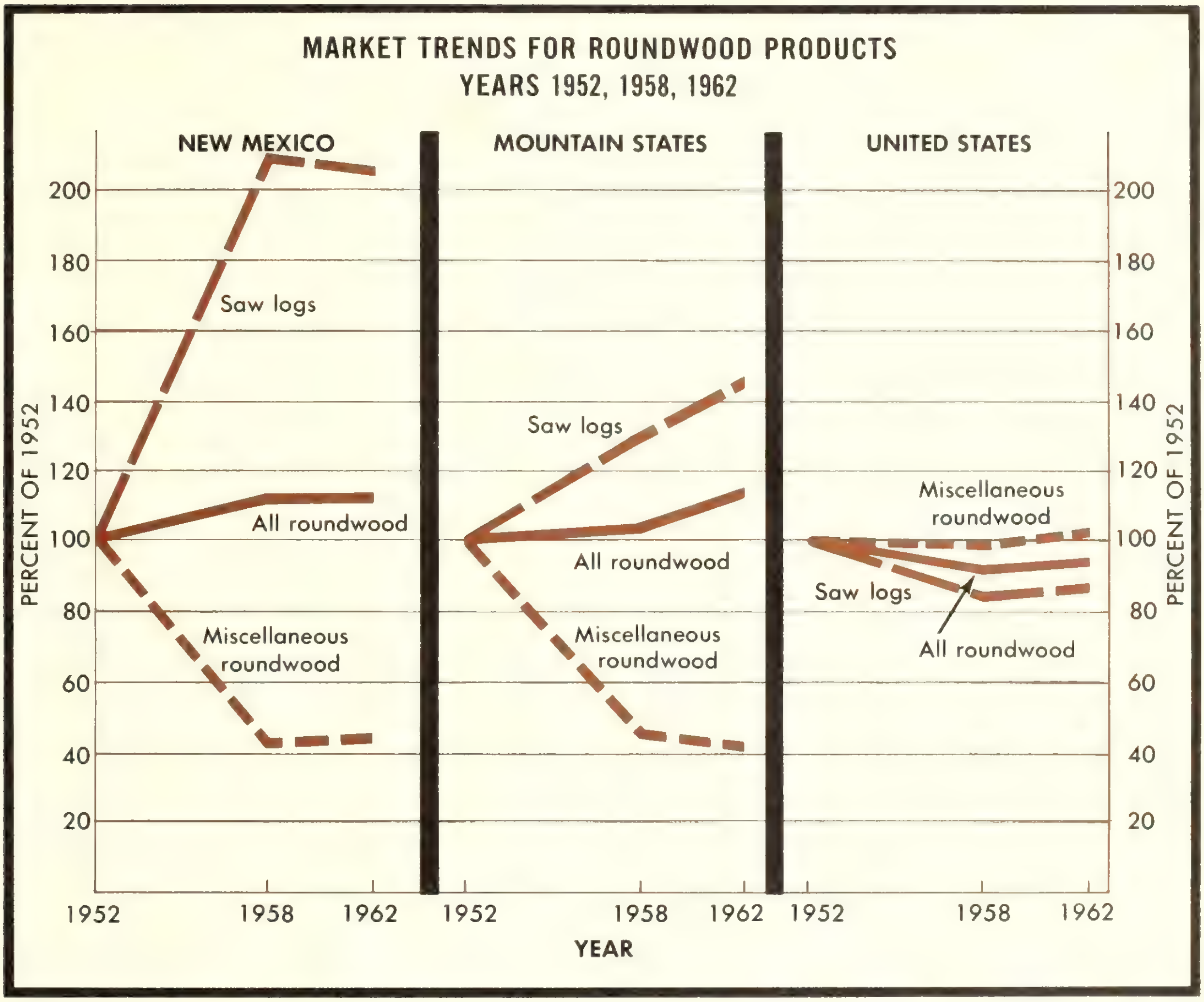
Successful management of the recreation, water, timber, and other resources on public lands depends to a large extent on a multiple-purpose road system. By relieving timber of much of the cost of the primary road system, large areas would become economically operable. The objective on the National Forests in New Mexico for the 10-year period 1963 to 1972 is to build an average of 217 miles of roads a year. This includes reconstruction of many roads that have deteriorated or are inadequate for modern needs. Most of the proposed financing is by direct government appropriations; the remainder is borne by timber operators under sale contracts. So far, annual accomplishments have been less than one-half the goal because of limitations on finances.

Better markets for small timber are needed

Increased use of the timber resource is directly contingent on better markets as well as better access. The total market for roundwood in New Mexico increased 14 percent between 1952 and 1962, thereby keeping pace with the increase for the Mountain States as a whole. This increase appears especially favorable when compared with the 7-percent decrease for the United States during the same period.

Although overall roundwood use has increased, there is at least one very important deficiency in the market situation. Since 1952 New Mexico's timber economy has become highly dependent on saw logs. Of the total market for roundwood products in 1952, saw logs accounted for 43 percent of the volume and other products 57 percent. In 1962 the percentages were 78 and 22, respectively. New Mexico's increase in saw log output between 1952 and 1962 takes on special significance when compared with the trends for both the Mountain States and the nation as a whole (see chart on next page). During this same period, markets for other roundwood decreased sharply in New Mexico, as well as in the Mountain States region as a whole. This was in direct contrast with the slight increase for the nation as a whole.

Important disadvantages are inherent in a timber economy that is heavily dependent



upon saw logs. Timberlands cannot be managed efficiently for saw logs alone. Many mature stands cannot be logged profitably unless there is a market for the smaller trees and for pulpwood chips from saw log residues. Opportunities for commercial thinnings in young stands do not exist without a market for small dimension material.

A substantial market for pulpwood would be a most favorable development. At present no round pulpwood is being cut, and only a small volume of pulp chips is being produced as sawmill byproducts—and these are shipped to out-of-State mills. It is unlikely that there can be any substantial pulpwood market until there is an industry within the State. The greatest gain would be an industry based on the use of roundwood as well as chips. Such a market not only would greatly enhance timber management opportunities but also would provide a profitable outlet for some of the present logging and sawmill residues.

Practically all commercial species in the State are suitable for pulping, and there are large volumes available. Rough estimates indicate that between 400,000 and 500,000 cords of pulpwood are available for annual harvest during the next 20 years at least. A cut of this magnitude not only would be feasible from the standpoint of sustained timber yields, but would be a technically desirable step toward improved timber management. Reliable estimates of just how much wood is available to serve possible pulpmill sites will require more detailed inventory information than is presently available.

However, the U.S. Forest Service has made some preliminary estimates of pulpwood supplies that could contribute to industrial development in the area of the Northern Rio Grande Resource Conservation and Development Project.[9] These estimates indicate that the Santa Fe and Carson National Forests have the following volumes in trees 5 to 11 inches d.b.h.:

	Million cords
Softwoods	**4.7**
Hardwoods	**.4**
Total	**5.1**

Roughly one-half of this volume is presently available for harvest. Several times this volume could be cut on lands in other ownerships within or close to the Project area. Roundwood as well as chips from sawmill residues (estimated annual potential of 92,000 units) would be an adequate supply for a medium-sized mill.[10]

Poles and posts are other products that hold greatest promise for expanding the market for timber of less than saw log size. About 235,000 posts were produced in New Mexico in 1962 and abundant material is available for expansion of this market. Market opportunities for utility poles are much

Treating plant of the Shollenbarger and Cazolla Lumber Company in Springer. This plant, which pressure treats thousands of poles and posts each year, is one of the few plants in New Mexico that specializes in small roundwood products.
Photo by Ewing McClain, Soil Conservation Service.

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[9] *A cooperative project (State and Federal agencies) created to improve the economic development within an area of 2.9 million acres in Taos, Rio Arriba, Sandoval, Los Alamos, Mora, and Santa Fe Counties.*

[10] *The University of New Mexico has been contracted by the Southwestern Region of the U.S. Forest Service to determine the feasibility of a pulpmill in northern New Mexico. Particularly important problems to be studied are wood supplies, adequacy of water for mill operation, and effluent handling.*

more limited because of rigid grade specifications and the relatively small area of sites suitable for pole production. Nevertheless, there are areas where poles can be produced in less time than sawtimber under good management. As pointed out by Mueller (1958), poles bring substantially higher returns per unit volume than saw logs. Both ponderosa pine and Douglas-fir are approved species for poles. However, ponderosa pine is more suitable for poles as well as posts because it is easier to treat.

Opportunities also exist for expanding the market for sawtimber-size material. Better quality control in manufacturing lumber is one approach; development of more types of products is another. Some of the improvement in quality of lumber in recent years has been the result of the trend towards fewer but larger and more efficient mills. In general, large mills are better equipped than small mills. For example, a study conducted in 1959 of certain aspects of the sawmill industry in New Mexico (Gray 1962) pointed out the following relationship between sawmill size and planing equipment:

Mill-size class *(Thousand board feet of production in 1959)*	**Mill with planers** *(Percent)*
50 or less	**0**
51 to 1,000	**43**
1,001 to 5,000	**62**
5,001 to 15,000	**58**
15,001 and over	**75**
Average	**46**

Similar relationships were noted in terms of other equipment—resaws, edgers, and trimmers.

The great preponderance of low grade ponderosa pine is a principal factor that has limited the variety of timber products from sawtimber in New Mexico. Some material of sawtimber size goes into round mine and farm timbers, poles, and miscellaneous industrial wood, but the great bulk is sawed into lumber—principally boards—as shown by the following results of the survey mentioned above (Gray 1962):

Lumber product	*Percent of all lumber*
Boards	**84**
Studs	**11**
Cants	**3**
Ties	**1**
Other[1]	**1**
Total	**100**

[1] *Mostly mine timbers*

Recent studies have been conducted regarding technical aspects of manufacturing a number of products other than lumber from sawtimber trees. One study (Barger 1965) was made to determine whether or not veneer volume and grade recovery from southwestern ponderosa pine is adequate to support a sheathing-grade plywood operation. This was a cooperative study between the U.S. Forest Service and the Southwest Pine Association. Logs of various grades were peeled into 1/10-inch-thick veneer on an 8-foot lathe under normal operating conditions of a commercial mill. Although results have not been published, preliminary indications are that a very satisfactory veneer output is possible from some material presently going into lumber.

Other studies at the Forest Products Laboratory (Barger and Fleischer 1964) indicate the technical feasibility of producing a variety of products from both low-grade lumber and low-grade timber. Overlaid siding, laminated beams, and laminated flooring can be produced from knotty material in standard lumber sizes through selective cutting, masking, and preassembly methods. Commercially acceptable grades of veneer, plywood, and particle board were also produced in these tests. If it is economically feasible to produce some of these materials, there will be a desirable broadening of the timber industry's base.

Reforestation and cultural work will increase future yields

The effort that is put into reforestation and stand improvement within the next few years can have an important bearing on timber supplies during the next generation or two. Trees take a long time to mature in

Planting ponderosa pine by machine on the Santa Fe National Forest. Of the 1,624 acres artificially regenerated on the National Forests in 1964, 924 acres were planted and 700 acres seeded. Seeding is more efficient than planting under certain conditions. A heavy cover of oak brush, such as seen here, has taken over big areas of ponderosa pine timberland in New Mexico. It must be removed or killed for successful reforestation. Aerial spraying of herbicides has been used successfully to kill it in some areas.

New Mexico—about 120 years for most species. Thinning in overstocked stands can substantially reduce the time necessary for trees to grow to a size desirable for such products as saw logs or commercial poles. At least 50 to 60 years must elapse before present stand improvement work can bear fruit in the form of products from intermediate or final cuts in stands that were thinned or pruned at an early age.

A very substantial area is currently in need of improvement of one type or another. Just how much work is needed cannot be estimated with reasonable accuracy until detailed inventories have been made. Such surveys are underway on many lands. National Forests, for example, are currently examining their lands on practically an acre-by-acre basis to determine the amount and type of work needed for management of timber and other values. Although these surveys will take many years to complete, data from more general surveys provide a basis for preliminary or interim estimates. These estimates are used in the following discussion.

About 220,000 acres are either denuded or stocked with less than 10 percent of the desirable number of trees per acre and need regeneration. In addition to this, part of the 2.1 million acres now poorly stocked (10-40 percent) should also be planted or seeded. The greatest share of the lands in need of regeneration is best suited for growing ponderosa pine. Successful regeneration of this species, either naturally or artificially, is usually dependent on thorough site preparation and protection from animals.

The amount of reforestation work that is presently being done in New Mexico falls far short of the effort necessary to put forest lands in shape to meet anticipated tim-

Thinned stand of ponderosa pine near Valle Grande Peak, Carson National Forest. This stand has been thinned from 2,000 stems per acre to about 430. Remaining trees are 4 to 7 inches d.b.h. and average 40 feet tall, and 30 years old.

ber demands. In 1964, only 1,907 acres of forest land were planted or seeded—1,624 on National Forests and 283 on private and other holdings. The former is less than one-third of the 5,100 acres that the Forest Service feels would be desirable on an annual basis during the decade 1963 to 1972.

Cultural measures—thinning, releasing, pruning—are necessary for accelerating growth and improving quality of trees that eventually will be harvested. Forest Survey data show about 2.2 million acres as being well stocked (70 percent or better) with trees of all types. However, many of these acres are not fully stocked with desirable trees; i.e., trees of the form, quality, and vigor considered necessary for management as crop trees. Also, many stands have far too many trees to permit optimum growth for sawtimber production. Removal of some of the poorer trees from stands that are still young enough to respond to treatment would accelerate growth of those selected for future harvest.

The Forest Service feels that the current program of stand improvement work on the National Forests should amount to about 72,000 acres a year. A lack of markets for commercial thinnings, and inadequate finances for other work permit only a fraction of desired accomplishments. In 1964 only about 6,500 acres were treated—almost all precommercial thinnings.

A much more vigorous program of reforestation and timber stand improvement could provide several benefits to the people of New Mexico. The big backlog of such work on public lands is particularly significant in view of recent national attention to improving the lot of economically depressed communities—such as many of those within the six counties included in the Northern Rio Grande Conservation and Development Project. Within this project area, on National Forest lands alone there are about 52,500 acres of better sites that need precommercial thinning to accelerate growth of potential crop trees, and 21,800 acres of denuded land that should be reforested. A substantial amount of labor would be needed for this work. Therefore, such a program would provide immediate economic assistance to the local area, and at the same time be of long-range benefit to one of the State's important natural resources.

Most farm and ranch holdings are not managed for timber production

Although a big job faces managers of public lands, progress is much greater than on private lands—where most owners have primary objectives other than timber management. This poses an important problem when considering future timber development in the State because it involves 1.9 million acres or 31 percent of the commercial forest area.

New Mexico is not unique in having to face this problem. However, the problem is more acute in New Mexico because a very high proportion (88 percent) of the private forest area is in farm and ranch ownership. As indicated earlier, this is twice the average for the Mountain States as a whole.

Traditionally, most farm and ranch owners either feel little would be gained by managing forests for a higher level of timber production, or do not know how to go about it. This was substantiated by a survey conducted among private owners in the northern part of New Mexico. Most of the owners indicated that their forest lands were used primarily for grazing; only 26 percent of them managed for timber production (Gray 1963).

What management work is needed on most private lands? Superficially, the present general condition of private lands compares favorably with the average of all lands. The growth rate on private lands is probably at least as high as the average for the State, and both cubic- and board-foot volumes per acre are only slightly less. The proportion of the area that is in sawtimber stands is practically the same on private as on all lands. However, this type of information is not adequate to assess management opportunities and problems. Detailed surveys are needed to determine site capability and tree quality as well as stocking and spacing of regeneration. The fact that such surveys are not being made on most private holdings is one indication of the problem of improving management.

What services are available to private owners? Actually, there are quite a few sources, both public and private. The New Mexico Department of State Forestry is one important source. This State agency, in addition to the responsibility for fire protection on nearly two million acres of State and private lands, provides management advice to private forest land owners. During fiscal year 1963-64, assistance was given 63 landowners whose combined holdings totaled 209,375 acres. The State of New Mexico Department of Development is another State agency that can assist private enterprise, particularly in industrial development. Federal agencies that work with private owners include the Southwestern Region of the Forest Service and the Soil Conservation Service. The Western Wood Products Association also has been active in assisting private owners through its tree farm program. There are now 11 tree farms totaling 206,644 acres in New Mexico. Many out-of-State forestry consultants are available to aid New Mexico's private owners.

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Appendix

Terminology

Forest Land

The term *forest land* includes (a) land which is at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking; and which has not been developed for other use; (c) afforested areas.

At the time the fieldwork for this report was performed, the minimum unit of area for forest land classification was 10 acres with a minimum width of stringer strips of 120 feet.

The principal classes of forest land are:

Commercial forest land. — Forest land which is (a) producing, or is physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; (c) not withdrawn from timber utilization.

Noncommercial forest land. — Three classes of noncommercial forest land are recognized: *Productive-reserved*, *Unproductive-nonreserved*, and *Unproductive-reserved*.

Productive-reserved is public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

Unproductive indicates forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions or forest land so physically inaccessible as to be unavailable economically in the foreseeable future.

Forest Types

Forest land is classified into types on the basis of tree species; the type name is that of the predominant species. The predominant species is the one which has a plurality of (a) gross cubic volume in sawtimber and poletimber stands, or (b) the number of stems in seedling and sapling stands. Both growing stock and cull trees are considered in the classification. Forest types which occur on both commercial and noncommercial forest land are:

Douglas-fir

Ponderosa pine

Fir-spruce

Limber pine[9]

Aspen

Additional forest types which occur only on noncommercial forest land are:

Pinyon-juniper

Chaparral

Other (unclassified)

Tree-Size Classes

Sawtimber-size tree

A tree 9.0 inches d.b.h. or larger for softwoods and 11.0 inches d.b.h. or larger for hardwoods.

Pole-size tree

A tree 5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods.

Sapling-seedling trees

Trees at least 1-foot high and less than 5.0 inches d.b.h.

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[9] *Although the limber pine type was considered commercial forest at the time of the inventory (1962) and is included as such in the appendix tables, it has subsequently been classed as noncommercial by Forest Survey.*

Tree-Merchantability Classes

Sawtimber tree

Live tree of commercial species, 9.0 inches d.b.h. or larger for softwoods and 11.0 inches d.b.h. or larger for hardwoods, that contains at least one 12-foot log to a merchantable top diameter and having the likelihood of eventually containing at least a 16-foot minimum saw log. Also, at least one-third of the board-foot volume must be free from rot or other defect.

Poletimber tree

Live tree of commercial species, 5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods, free of rot and having the likelihood of growing into a sawtimber tree.

Sapling and seedling trees

Live trees of commercial species, less than 5.0 inches d.b.h., with form and quality to qualify as potential poletimber trees.

Growing stock trees

Sawtimber trees, poletimber trees, saplings and seedlings; i.e., all live trees except cull trees.

In discussion and tables on volumes, growth, and mortality, the term *growing stock* refers only to sawtimber trees and poletimber trees; i.e., all live trees 5.0 inches d.b.h. and larger (except cull trees). Saplings and seedlings are not part of growing stock in this usage of the term.

Cull tree

Live tree of sawtimber or poletimber size that is unmerchantable for saw logs, now or prospectively, because of rot or other defect, or species.

Sound cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull with at least one-half of this cull the result of sweep, crook, or other sound defect. Also included are sound trees which do not contain at least one 12-foot saw log.

b. Poletimber-size trees that are unlikely to grow into sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, crooks, or girdling by porcupine. No rot may be present.

Rotten cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull, with more than half of the cull due to rot.

b. Poletimber-size trees showing any evidence of rot in the main stem.

Mortality tree

A tree 5.0 inches d.b.h. or larger, standing or down, which has died within the past 5 years and was not a cull tree at time of death.

Salvable dead tree

Dead tree 5.0 inches d.b.h. or larger, standing or down (but not lying on the ground) which has 50 percent or more of its cubic-foot volume in sound wood.

Stand-Size Classes

Sawtimber stands

A stand at least 10 percent stocked, with half or more of this stocking in sawtimber and poletimber trees and with sawtimber stocking at least equal to poletimber stocking.

> *Old-growth sawtimber.*—A sawtimber stand in which 50 percent or more of the net board-foot volume is in trees of rotation age or older.
>
> *Young-growth sawtimber.* — A sawtimber stand in which 50 percent or more of the net board-foot volume is in trees under rotation age.

Poletimber stand

A stand at least 10 percent stocked, with half or more of this stocking in sawtimber and/or poletimber trees and with poletimber stocking exceeding that of sawtimber stocking.

Sapling and seedling stand

A stand at least 10 percent stocked, with more than half of this stocking in saplings and/or seedlings.

Nonstocked area

An area not qualifying as a sawtimber, poletimber, or a seedling-sapling stand; i.e., normally an area less than 10 percent stocked.

Stocking

Stocking is a measure of the degree to which growing space is utilized by live trees. In this report it is expressed as the percentage of the available space that is occupied by tree crowns as viewed on aerial photographs.

Well-stocked stand

A stand that is 70 percent or more covered by tree crowns.

Medium-stocked stand

A stand with 40 to 70 percent coverage by tree crowns.

Poorly-stocked stand

A stand with 10 to 40 percent coverage by tree crowns.

Nonstocked area

An area with less than 10 percent coverage by tree crowns.

Timber Volume

All-timber volume

Volume in cubic feet of sound wood in the bole of growing stock, cull, and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top inside bark.

Growing stock volume

Net volume in cubic feet of sawtimber trees and poletimber trees from stump to a minimum 4.0-inch top inside bark.

Live sawtimber volume

Net volume in board feet, International ¼-inch rule, of the saw log portion of sawtimber trees.

Saw log portion

That portion of the bole of sawtimber trees between the stump and the merchantable top.

Merchantable top

The point at which the upper limit of saw log merchantability is limited either by limbs or by a minimum diameter. The latter ranges from 5 to 10 inches inside bark depending on d.b.h. and species.

Upper-stem portion

That part of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches inside bark.

Quality class

A classification of sawtimber volume in terms of log grades. Four grades are recognized and distinguished by the occurrence and characteristics of knots. The log grades corresponding to the quality classes are:

Grade 1 (select logs) are essentially smooth and surface clear, except that in logs 16 inches and larger in diameter a few visible knots are permitted, providing there are no more than 1 large knot, or 2 medium or small knots, or 4 pin knots. Knot sizes for all grades are:

Pin knots — 0.5 inch or less
Small knots — 0.5 to 0.75 inch
Medium knots — 0.75 to 1.5 inches
Large knots — over 1.5 inches

Occasionally, logs with a greater number of knots are admitted provided these knots may be boxed in an area not exceeding one-third the area of one face or an equivalent area of two faces.

Grade 2 (shop logs) display relatively few knots of any size, so spaced that at least 50 percent of the surface of the log is in smooth, clear areas, the size of which must be at least one-fourth the girth of the log in width, by 4 feet or more in length.

A log with no more than 12 medium or smaller knots, or more than 8 large ones, may be immediately classed as grade 2. If this number of knots is exceeded, the clear area basis governs.

Grade 3 (common logs) display either (a) pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab, or (b) 16 dead knots (an average of 4 per face) averaging medium in size.

Grade 4 (low common logs) display medium, large, and very large live and/or dead knots in excess of the numbers permitted in grades 2 and 3.

Growth

Net annual growth of sawtimber or growing stock

The average annual change, calculated from the total change over a 10-year period, in net board-foot or cubic-foot volume of live sawtimber or growing stock on commercial forest land.

Mortality

Net annual mortality of sawtimber or growing stock

The average annual net board-foot or cubic-foot volume removed from live sawtimber or growing stock through death, calculated from the total net volume removed by such causes over a 10-year period.

Timber Cut

Timber cut from growing stock

The volume of sound wood in live sawtimber and poletimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Timber cut from sawtimber

The net board-foot volume of live sawtimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Logging residues from growing stock

The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging on commercial forest land and not converted to timber products.

Ownership Classes

National Forest lands

Federal lands which have been designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas.

Other Federal lands

Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies.

State lands

Lands owned by the State.

Forest industry lands

Lands owned by companies or individuals operating wood-using plants.

Farmer-owned lands

Lands owned by operators of farms or ranches.

Miscellaneous private lands

Privately owned lands other than forest-industry or farmer-owned lands.

Principal Tree Species

Softwoods	
Douglas-fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Fir, corkbark	*A. lasiocarpa arizonica*
Fir, white	*A. concolor*
Juniper	*Juniperus spp.*
Pine, limber	*Pinus flexilis*
Pine, ponderosa	*P. ponderosa*
Pinyon	*P. spp.*
Spruce, Engelmann	*Picea engelmannii*
Hardwoods	
Aspen, quaking	*Populus tremuloides*
Cottonwood	*Populus spp.*

Survey Methods

Area statistics were determined by two methods:[11] (1) On National Forests, forest lands were mapped on aerial photographs according to forest type, stand size, and crown density. Photo delineations were transferred to base maps. Maps were then dot counted to obtain the estimates of area by the various land and forest classes. (2) For all lands not in National Forest ownership (except certain Indian Reservations), a sampling procedure was used. Points were classified on aerial photos to determine the proportion of area by forest versus nonforest, class of forest, and ownership. A percentage of the points was checked on the ground for correctness of classification. Results of the field check were then used to adjust photo estimates of proportions. Acreages were determined by applying the adjusted proportions to the total acreage of the sampled area.

Volume estimates are based on tree measurements taken on 5,202 sample areas located at random on commercial forest land. Sample locations were pricked on aerial photos. These were then located in the field and marked to permit remeasurement in future surveys. Two different sampling procedures were used: (1) On National Forests, measurements were taken on circular plots of fixed radius. Each plot consisted of four circular and concentric subplots. The area of subplots and size class of trees (live and dead) of commercial species tallied on each are as follows:

1/250-acre — seedlings
1/50-acre — saplings
1/10-acre — pole-size
1/4-acre — sawtimber-size

(2) On lands not in National Forest ownership, sample locations were approximately 1 acre in size. Each location was subsampled at 10 points. At each point, trees were tallied on two plots — one of fixed radius (1/250-acre) and one of variable radius. On the former, all trees were measured and live noncull trees were classified as crop trees or excess trees from the standpoint of management treatment. The variable radius plot (trees are sampled in proportion to their basal area) was used for live sawtimber trees and for mortality sawtimber trees.

Both of the systems described above included the customary measurements and classifications of trees for volume and quality. Increment borings were taken for growth estimates.

Per-acre values of volume, growth, and mortality were obtained from the field samples. These averages, applied to area estimates, provided volumes shown in appendix tables.

Estimates of timber cut are based on periodic surveys of forest industries. The latest survey was in 1962 and is the basis for data shown in the appendix tables. Utilization trends discussed in the text are based mainly on lumber production data, since information on output of all products is available only for 1952, 1960, and 1962.

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[11] *Methods described here are those that were used for inventorying all forest lands except those within the Mescalero, Navajo, Ute Mountain, Zuni, Jicarilla, and United Pueblo Indian Reservations. Data for these lands were provided by the Bureau of Indian Affairs from their management plan inventories.*

Reliability of Estimates

Accuracy objectives for the timber inventory of New Mexico were as follows:

	Allowable error[1]
Commercial forest area	**3 percent per million acres**
Noncommercial forest area	**10 percent per million acres**
Growing stock volume on commercial forest land	**10 percent per billion cubic feet**
Net annual growth of growing stock on commercial forest land	**15 percent per billion cubic feet**

[1] *In terms of one standard error.*

Sampling errors actually obtained for the State as a whole are not known. They have been computed for certain parts of the State from basic data provided by some of the several agencies that made inventories of their own lands. For certain large areas, however, the basic field and photo data necessary for computing errors are not available.

The following sampling errors have been computed for timber cut and timber products output in 1962:

	Volume	*Sampling error*[1] *(Percent)*
Timber cut from growing stock	**39,601 M cu. ft.**	**10.3**
Timber cut from sawtimber	**241,412 M bd. ft.**	**10.9**
Timber products output	**46,259 M cu. ft.**	**10.2**

[1] *In terms of one standard error.*

Timber Statistics

Table 1.—**Area by land classes, New Mexico, 1962**

Land class	Thousand acres
Commercial forest land	6,269
Unproductive forest land	11,357
Productive-reserved forest land	561
Total forest land	18,187
Nonforest land	59,579
All land	[1]77,766

[1] *From U.S. Bureau of the Census, Land and Water Areas of the Unted States, 1960.*

Table 2.—**Area of commercial forest land by ownership classes, New Mexico, 1962**

Ownership class	Thousand acres
National Forest	3,458
Other Federal:	
Bureau of Land Management	77
Indian	617
Miscellaneous Federal	9
Total other Federal	703
State	172
Farmer-owned	1,557
Miscellaneous private[1]	379
All ownerships	6,269

[1] *Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 3.—**Area of commercial forest land by stand-size and by ownership classes, New Mexico, 1962**

Stand-size class	All ownerships	National Forest	Other Public	Farmer and misc. private
	Thousand acres			
Sawtimber stands:				
Old growth	2,971	1,707	547	717
Young growth	2,483	1,243	286	954
Total	5,454	2,950	833	1,671
Poletimber stands	426	275	19	132
Sapling and seedling stands	169	16	20	133
Nonstocked area	220	217	3	—
All classes	6,269	3,458	875	1,936

Table 4.—**Area of commercial forest land, by stand-volume classes for sawtimber and other stand-size classes, New Mexico, 1962**

Stand volume per acre[1]	Area by stand-size classes		
	All stands	Sawtimber stands	Other stands
	Thousand acres		
Less than 1,500 board feet	1,099	349	750
1,500 to 5,000 board feet	4,312	4,254	58
5,000 to 10,000 board feet	644	642	2
10,000 to 20,000 board feet	209	204	5
More than 20,000 board feet	5	5	—
All classes	6,269	5,454	815

[1] *Net volume, International 1/4-inch rule.*

Table 5.—**Area of commercial forest land, by stocking classes of all live trees and by stand-size classes, New Mexico, 1962**

Stocking class	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
70 percent or more	2,176	2,019	100	57	—
40 to 70 percent	1,779	1,638	120	21	—
10 to 40 percent	2,094	1,797	206	91	—
Less than 10 percent	220	—	—	—	220
All classes	6,269	5,454	426	169	220

Table 6.—**Area of commercial forest land, by forest types and by ownership classes, New Mexico, 1962**

Forest type	All ownerships	Public ownerships	Private ownerships
	Thousand acres		
Douglas-fir	1,000	582	418
Ponderosa pine	4,334	3,262	1,072
Limber pine	43	10	33
Fir-spruce	525	290	235
Aspen	367	189	178
All types	6,269	4,333	1,936

Table 7.—**Area of commercial forest land by forest types and by stand-size classes, New Mexico, 1962**

Forest type	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	Thousand acres				
Douglas-fir	1,000	902	85	([1])	13
Ponderosa pine	4,334	3,885	154	101	194
Limber pine	43	43	—	—	—
Fir-spruce	525	445	27	40	13
Aspen	367	179	160	28	—
All types	6,269	5,454	426	169	220

[1] *Less than 0.5 thousand acres.*

Table 8.—**Area of noncommercial forest land, by forest types, New Mexico, 1962**

Forest type	All areas	Productive reserved areas	Unproductive areas
	Thousand acres		
Douglas-fir	122	120	2
Ponderosa pine	347	307	40
Limber pine	([1])	([1])	—
Fir-spruce	129	122	7
Aspen	33	12	21
Chaparral	652	—	652
Pinyon-juniper	10,635	—	10,635
All types	11,918	561	11,357

[1] *Less than 0.5 thousand acres.*

Table 9.—**Number of growing-stock trees on commercial forest land, by diameter classes and by softwoods and hardwoods, New Mexico, 1962**

D.B.H. class (inches)	All species	Softwoods	Hardwoods
	Thousand trees		
1.0-2.9	456,992	416,542	40,450
3.0-4.9	284,019	253,972	30,047
5.0-6.9	188,436	166,988	21,448
7.0-8.9	115,489	106,891	8,598
9.0-10.9	77,504	72,471	5,033
11.0-12.9	44,314	41,080	3,234
13.0-14.9	35,410	32,305	3,105
15.0-16.9	23,869	22,273	1,596
17.0-18.9	17,153	16,323	830
19.0-28.9	24,580	24,030	550
29.0-38.9	1,539	1,539	—
39.0 and larger	69	69	—
All classes	1,269,374	1,154,483	114,891

Table 10.—**Volume of timber on commercial forest land, by class of timber and by softwoods and hardwoods, New Mexico, 1962**

Class of timber	All species	Softwoods	Hardwoods
	- - - - - - *Thousand cubic feet* - - - - - -		
Sawtimber trees:			
Saw-log portion	5,203,513	5,029,306	174,207
Upper-stem portion	468,663	416,663	52,000
Total	5,672,176	5,445,969	226,207
Poletimber trees	944,063	791,196	152,867
All growing-stock trees	6,616,239	6,237,165	379,074
Sound cull trees:			
Sawtimber-size trees	173,859	127,340	46,519
Poletimber-size trees	113,201	66,014	47,187
Total	287,060	193,354	93,706
Rotten cull trees:			
Sawtimber-size trees	87,464	40,284	47,180
Poletimber-size trees	81,980	9,199	72,781
Total	169,444	49,483	119,961
Salvable dead trees:			
Sawtimber-size trees	373,671	367,137	6,534
Poletimber-size trees	70,043	43,886	26,157
Total	443,714	411,023	32,691
All timber	7,516,457	6,891,025	625,432

Table 11.—**Volume of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, New Mexico, 1962**

Ownership class	All species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
National Forest	3,387	3,326	61
Other public	1,369	1,341	28
Farmer and misc. private[1]	1,860	1,570	290
All ownerships	6,616	6,237	379
		SAWTIMBER *(Million board feet)*[2]	
National Forest	14,859	14,678	181
Other public	6,243	6,153	90
Farmer and misc. private[1]	7,241	6,279	962
All ownerships	28,343	27,110	1,233

[1] *Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *International 1/4-inch rule.*

Table 12.—Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, New Mexico, 1962

Stand-size class	All species	Softwoods	Hardwoods
		GROWING STOCK *Million cubic feet*	
Sawtimber stands	6,320	6,008	312
Poletimber stands	231	164	67
Sapling and seedling stands	38	38	(1)
Nonstocked areas	27	27	(1)
All classes	6,616	6,237	379
		SAWTIMBER *(Million board feet)*[2]	
Sawtimber stands	27,662	26,457	1,205
Poletimber stands	493	466	27
Sapling and seedling stands	63	63	(1)
Nonstocked areas	125	124	1
All classes	28,343	27,110	1,233

[1] *Less than 0.5 million feet.*
[2] *International 1/4-inch rule.*

Table 13.—Volume of growing stock on commercial forest land by species and diameter classes, New Mexico, 1962

Species	Diameter class (inches at breast height)										
	All Classes	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-28.9	29.0-38.9	39.0 & larger
	Million cubic feet										
Softwoods:											
Douglas-fir	942	47	83	84	81	121	89	93	298	37	9
Ponderosa pine[1]	3,837	137	175	232	255	349	444	510	1,466	257	12
Limber pine[2]	158	12	25	15	29	26	17	5	25	3	1
True firs[3]	594	115	75	78	61	65	50	35	92	21	2
Engelmann spruce	706	50	72	125	89	81	76	68	125	20	—
Total	6,237	361	430	534	515	642	676	711	2,006	338	24
Hardwoods:											
Aspen	379	54	48	51	50	66	51	31	28	(4)	—
Total	379	54	48	51	50	66	51	31	28	(4)	—
All species	6,616	415	478	585	565	708	727	742	2,034	338	24

[1] *Includes a negligible amount of Apache, Arizona, and Chihuahua pine.*
[2] *Includes a negligible amount of Mexican white and bristlecone pines.*
[3] *Includes subalpine, white, and corkbark firs.*
[4] *Less than 0.5 million cubic feet.*

Table 14—**Volume of sawtimber on commercial forest land, by species and diameter classes, New Mexico, 1962**

Species	Diameter class (inches at breast height)								
	All classes	9.0-10.9[1]	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-28.9	29.0-38.9	39.0 & larger
	Million board feet[2]								
Softwoods:									
Douglas-fir	5,025	525	485	796	526	584	1,821	229	59
Ponderosa pine[3]	16,188	776	969	1,402	1,950	2,315	7,183	1,502	91
Limber pine[4]	640	77	157	139	89	25	128	20	5
True firs[5]	1,976	327	283	314	246	174	498	123	11
Engelmann spruce	3,281	681	493	454	425	383	722	123	—
Total	27,110	2,386	2,387	3,105	3,236	3,481	10,352	1,997	166
Hardwoods:									
Aspen	1,233	0	265	358	279	170	161	(6)	—
Total	1,233	0	265	358	279	170	161	(6)	—
All species	28,343	2,386	2,652	3,463	3,515	3,651	10,513	1,997	166

[1] *Softwoods only.*
[2] *International 1/4-inch rule.*
[3] *Includes a negligible amount of Apache, Arizona, and Chihuahua pine.*
[4] *Includes a negligible amount of Mexican white and bristlecone pines.*
[5] *Includes subalpine, white, and corkbark firs.*
[6] *Less than 0.5 million board feet.*

Table 15.—**Volume of sawtimber on commercial forest land, by species[1] and quality classes, New Mexico, 1962**

Species	Quality classes				
	All classes	1	2	3	4
	Million board feet[2]				
Softwoods:					
Ponderosa pine	16,188	139	892	1,674	13,483
Total	16,188	139	892	1,674	13,483

[1] *Ponderosa pine is the only species log-graded.*
[2] *International 1/4-inch rule.*

Table 16.—Volume of salvable dead sawtimber-size trees on commercial forest land, by softwoods and hardwoods, New Mexico, 1962

Species group	Volume
	Thousand board feet[1]
Softwoods	1,844,898
Hardwoods	35,657
All species	1,880,555

[1] *International 1/4-inch rule.*

Table 17.—Net annual growth and annual cut of growing stock on commercial forest land, by species, New Mexico, 1962

Species	Net annual growth	Annual timber cut
	Thousand cubic feet	
Softwoods:		
Douglas-fir	-422	7,443
Ponderosa pine[1]	40,543	21,587
True firs[2]	7,536	1,841
Engelmann spruce	14,108	8,465
Limber pine[3]	1,592	260
Total	63,357	39,596
Hardwoods		
(Aspen)	-10,257	5
All species	53,100	39,601

[1] *Includes a negligible amount of Apache, Arizona, and Chihuahua pines*

[2] *Includes subalpine, white, and corkbark firs.*

[3] *Includes a negligible amount of Mexican white and bristlecone pines.*

Table 18.—Annual cut of growing stock on commercial forest land, by ownership classes and by softwoods and hardwoods, New Mexico, 1962

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
	ANNUAL TIMBER CUT			
	(Thousand cubic feet)			
Softwoods	39,598	20,709	4,474	14,415
Hardwoods	3	3	([2])	([3])
All Species	39,601	20,712	4,474	14,415

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *Less than 0.5 thousand cubic feet.*

[3] *A small quantity of hardwoods has been combined with softwoods to avoid disclosing individual operations.*

Table 19.—**Net annual growth and annual cut of sawtimber on commercial forest land, by species, New Mexico, 1962**

Species	Net annual growth	Annual timber cut
	Thousand board feet[1]	
Softwoods:		
Douglas-fir	–2,367	45,381
Ponderosa pine[2]	153,582	131,558
True firs[3]	9,627	11,104
Engelmann spruce	65,772	51,658
Limber pine[4]	2,759	1,690
Total	229,373	241,391
Hardwoods (Aspen)	–13,183	21
All species	216,190	241,412

[1] *International 1/4-inch rule.*

[2] *Includes a negligible amount of Apache, Arizona, and Chihuahua pines.*

[3] *Includes subalpine, white, and corkbark firs.*

[4] *Includes a negligible amount of Mexican white and bristlecone pines.*

Table 20.—**Annual cut of sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, New Mexico, 1962**

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
		ANNUAL TIMBER CUT		
		(Thousand board feet)[2]		
Softwoods	241,399	126,248	27,277	87,874
Hardwoods	13	11	2	([3])
All species	241,412	126,259	27,279	87,874

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *International 1/4-inch rule.*

[3] *A small quantity of hardwoods has been combined with softwoods to avoid disclosing individual operations.*

Table 21.—Annual mortality of growing stock and sawtimber on commercial forest land, by species, New Mexico, 1962

Species	Growing stock	Sawtimber
	Thousand cubic feet	*Thousand board feet*[1]
Softwoods:		
Douglas-fir	14,420	77,866
Ponderosa pine[2]	10,156	41,002
Limber pine[3]	564	3,260
True firs[4]	7,147	36,112
Engelmann spruce	878	3,323
Total	33,165	161,563
Hardwoods	20,564	50,280
All species	53,729	211,843

[1] *International 1/4-inch rule.*

[2] *Includes a negligible amount of Apache, Arizona, and Chihuahua pine.*

[3] *Includes a negligible amount of Mexican white and bristlecone pines.*

[4] *Includes subalpine, white, and corkbark firs.*

Table 22.—Annual mortality of growing stock and sawtimber on commercial forest land, by causes and by softwoods and hardwoods, New Mexico, 1962

Cause of death	Growing stock			Sawtimber		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	- - - *Thousand cubic feet* - - -			- - - *Thousand board feet*[1] - - -		
Fire	3,604	3,604	——	6,121	6,121	——
Insects	18,934	11,198	7,736	63,997	59,472	4,525
Disease	26,483	14,031	12,452	116,987	71,232	45,755
Other	4,708	4,332	376	24,738	24,738	—
All causes	53,729	33,165	20,564	211,843	161,563	50,280

[1] *International 1/4-inch rule.*

Table 23.—**Total output of timber products, by products, by type of material used, and by softwoods and hardwoods, New Mexico, 1962**

Product and species group	Total output in standard units		Output from roundwood from growing stock		Output from roundwood from nongrowing stock		Output from plant by-products (standard units)
	Unit	Number	Standard units	M cubic feet	Standard units	M cubic feet	
Saw logs:							
Softwood	M bd. ft.[1]	247,620	225,086	32,638	22,534	3,267	0
Hardwood	M bd. ft.[1]	(3)	(3)	(3)	(3)	(3)	0
Total	M bd. ft.[1]	247,620	225,086	32,638	22,534	3,267	0
Poles:							
Softwood	M pcs.	3	2	15	1	10	0
Hardwood	M pcs.	(4)	(4)	3	(4)	5	0
Total	M pcs.	3	2	18	1	15	0
Mine timbers (round):							
Softwood	M cu. ft.	410	387	387	23	23	0
Hardwood	M cu. ft.	0	0	0	0	0	0
Total	M cu. ft.	410	387	387	23	23	0
Miscellaneous industrial wood:[2]							
Softwood	M cu. ft.	251	176	176	75	75	0
Hardwood	M cu. ft.	23	(3)	(3)	23	23	0
Total	M cu. ft.	274	176	176	98	98	0
Posts:							
Softwood	M pcs.	230	11	12	219	253	0
Hardwood	M pcs.	5	0	0	5	6	0
Total	M pcs.	235	11	12	224	259	0
Fuelwood:							
Softwood	M std. cds.	154	5	361	126	8,777	23
Hardwood	M std. cds.	3	0	0	3	228	0
Total	M std. cds.	157	5	361	129	9,005	23
All products:							
Softwood	M cu. ft.	—	—	33,589	—	12,405	—
Hardwood	M cu ft.	—	—	3	—	262	—
Total	M cu. ft.	—	—	33,592	—	12,667	—

[1] *International 1/4-inch rule.*

[2] *Includes converter poles, excelsior bolts, charcoal wood, and house logs.*

[3] *A small quantity of hardwoods has been combined with softwoods to avoid disclosing individual operations.*

[4] *Less than 0.5 thousand pieces.*

Table 24.—**Total output of roundwood products, by source and by softwoods and hardwoods, New Mexico, 1962**

Source	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Growing-stock trees:[1]			
Sawtimber	33,458	33,453	5
Poletimber	134	134	0
Total	33,592	33,587	5
Cull trees[1]	0	0	0
Salvable dead trees[1]	11,596	11,377	219
Other sources[2]	1,071	1,028	43
All sources	46,259	45,992	267

[1] *On commercial forest land.*

[2] *Includes noncommercial forest land, nonforest land such as fence rows, trees less than 5.0 inches in diameter, and tree tops and limbs.*

Table 25.—**Annual timber cut from growing stock on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, New Mexico, 1962**

Products and residues	All species	Softwoods	Hardwoods
	Thousand cubic feet		
Roundwood products:			
Saw logs	32,638	32,638	(2)
Poles	18	15	3
Mine timbers	387	387	0
Misc. industrial wood[1]	176	176	(2)
Posts	12	12	0
Fuelwood	361	361	0
All products	33,592	33,589	3
Logging residues	6,009	6.009	0
Timber cut	39,601	39,598	3

[1] *Includes converter poles, excelsior bolts, charcoal wood, and house logs.*

[2] *A small quantity of hardwoods has been combined with softwoods to avoid disclosing individual operations.*

Table 26.—**Annual timber cut from live sawtimber on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, New Mexico, 1962**

Products and residues	All species	Softwoods	Hardwoods
	Thousand board feet[1]		
Roundwood products:			
Saw logs	225,086	225,086	(2)
Poles	42	35	7
Mine timbers	1,130	1,130	0
Misc. industrial wood[3]	1,160	1,160	(2)
Posts	63	63	0
Fuelwood	312	312	0
All products	227,793	227,786	7
Logging residues	13,619	13,619	0
Timber cut	241,412	241,405	7

[1] *International 1/4-inch rule.*

[2] *A small quantity of hardwoods has been combined with softwoods to avoid disclosing individual operations.*

[3] *Includes converter poles, excelsior bolts, charcoal wood, and house logs.*

Table 27.—**Volume of plant residues by industrial source and type of residue, and by softwoods and hardwoods, New Mexico, 1962**

Industrial source	Species and character of residues								
	All species			Softwoods			Hardwoods		
	Total	Coarse[1]	Fine[2]	Total	Coarse	Fine	Total	Coarse	Fine
	Thousand cubic feet								
Lumber industry	17,790	8,378	9,412	17,790	8,378	9,412	0	0	0
Veneer and plywood industry	0	0	0	0	0	0	0	0	0
Other primary industries	53	53	0	49	49	0	4	4	0
All industries	17,843	8,431	9,412	17,839	8,427	9,412	4	4	0

[1] *Unused material suitable for chipping, such as slabs, edgings, and veneer cores.*

[2] *Unused material not suitable for chipping, such as sawdust and shavings.*

Table 28.—**Timber growth projections, all species, New Mexico, 1962-92**[1]

Period	Assumed cut	Projected growth
	GROWING STOCK *(Thousand cubic feet)*	
1962	39,601	53,100
1972	69,600	70,800
1982	93,400	86,500
1992	116,000	100,900
	SAWTIMBER *(Thousand board feet)*[2]	
1962	241,412	216,190
1972	309,100	236,300
1982	367,400	252,600
1992	423,800	268,300

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[1] *These projections assume that: (1) There will be practically no change in the area of commercial forest land, (2) demands for timber products will rise along with predicted increases in the nation's population and income, (3) timber will maintain its market position relative to competitive materials, and (4) timber management will become more intensive, especially with respect to improving the number, spacing, vigor, and age-class distribution of trees.*

[2] *International 1/4-inch rule.*

MAJOR FOREST TYPES

NEW MEXICO

1964

FOREST SURVEY ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
AND
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
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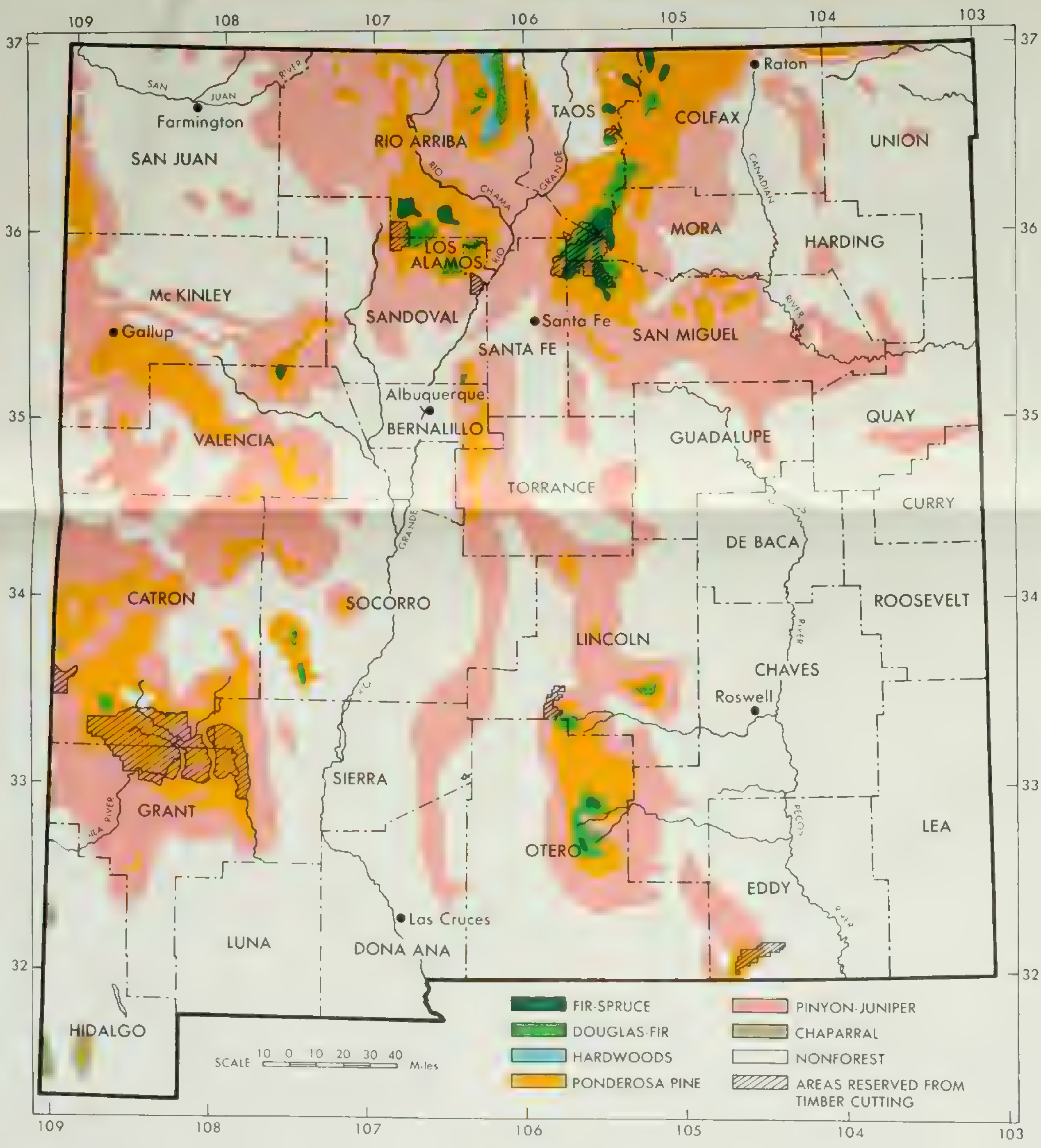

RECENT FOREST SURVEY PUBLICATIONS

Title	Number	Date
Timber Resources of Idaho	Forest Survey Release No. 3	1962
The Forest Resources of Western Montana	Resource Bulletin INT-1	1963
*The Forests of Wyoming	Resource Bulletin INT-2	1963
*The Forest Resources of Colorado	Resource Bulletin INT-3	1964
Output of Timber Products in Montana, 1962	Research Paper INT-11	1964
Forest Products Output in Utah and Nevada, 1962	Research Paper INT-12	1964
Output of Timber Products in Idaho, 1962	Research Paper INT-13	1964
*Timber Products Output in Colorado, Wyoming, and Western South Dakota	Research Paper INT-14	1964
*Timber Products Output in Arizona and New Mexico, 1962	Research Paper INT-15	1964
Forests in Utah	Resource Bulletin INT-4	1965
Site Index Curves for Engelmann Spruce in the Northern and Central Rocky Mountains	Research Note INT-42	1966

FORTHCOMING FOREST SURVEY PUBLICATION

Title	Number	Date
*Arizona's Forests	Resource Bulletin INT-6	1966

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ARIZONA'S FORESTS

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COVER PHOTO

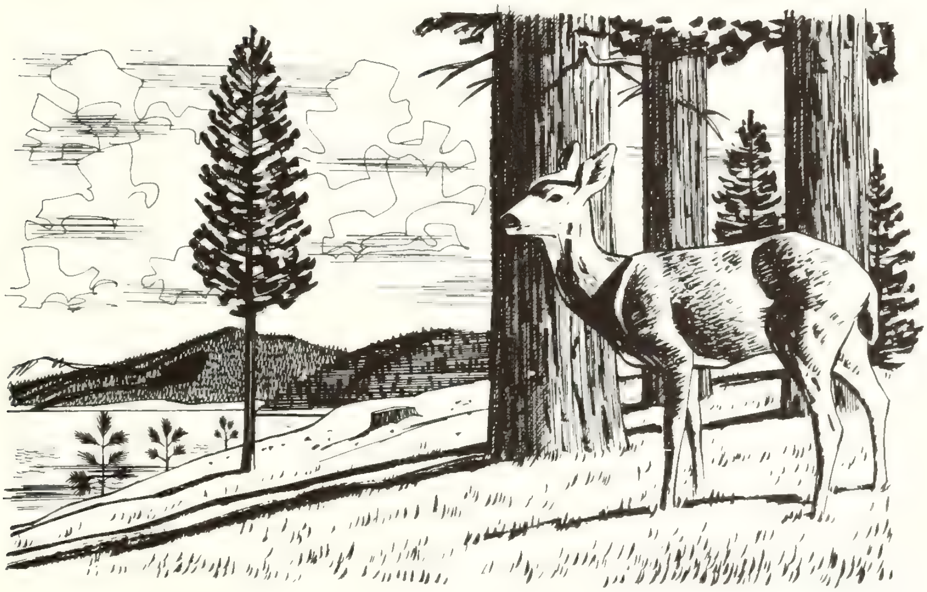
Big Lake with the White Mountains in the background. This view from a ponderosa pine stand on the Apache National Forest near Springerville is one of the many scenic settings to be found on Arizona's forest lands.

U. S. Forest Service
Resource Bulletin INT-6

1966

ARIZONA'S FORESTS

John S. Spencer, Jr.



Rocky Mountain Forest and Range Experiment Station
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FOREWORD

This report is concerned primarily with timber. It presents figures regarding significant factors bearing on the present economics of this resource. Another purpose is to describe some of the most important considerations that bear on future development of the timber resource. Other forest values — water, recreation, and forage — are discussed briefly. Trends in use of these resources must be considered in relation to timber, because practically no forest lands are managed for timber alone.

Timber inventory statistics in this report are the most reliable that have ever been collected for Arizona's forests. The Southwestern Region of the U. S. Forest Service conducted surveys of National Forests, the Bureau of Indian Affairs of Indian Reservations, and the Intermountain Forest and Range Experiment Station of the other lands. A survey of timber cut and timber products output was done on a cooperative basis by the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, and Intermountain Forest and Range Experiment Station, Ogden, Utah. The Intermountain Station compiled data from these various surveys for this report.

Meaningful comparisons cannot be made between inventory statistics in this report and those shown in the last two national timber appraisals. Differences in figures in this report from those for 1952 as shown in **Timber Resources for America's Future** (U. S. Forest Serv. 1958)[1] do not reflect actual changes in forest conditions. The 1952 figures were not based on a complete survey. Also, in the intervening years, there have been changes in standards for classifying trees and commercial forest land. Inventory statistics in **Timber Trends in the United States** (U. S. Forest Serv. 1965) were not based on a complete inventory and therefore do not agree with figures in this report. The latter are based on fieldwork completed in 1962, but complete data were not available for the Timber Trends report because compilations were not finished until late 1964.

Definitions of terms, survey methods, reliability of estimates, and detailed timber statistics will be found in the Appendix, which also contains a generalized forest type map.

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[1] *Names and dates in parentheses refer to Literature Cited, page 37.*

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STATISTICAL HIGHLIGHTS

FOREST AREA

- The forest area is 20.6 million acres — 28 percent of Arizona's land area.
- The pinyon-juniper type covers 12.2 million acres — 17 percent of the land area of the State.
- The commercial forest includes 4 million acres.
- Ninety-six percent of the commercial forest area is in public ownership.
- The National Forests account for 66 percent of the commercial forest.
- Sawtimber stands comprise 94 percent of the commercial forest area — a higher proportion than for any other State.
- Ponderosa pine is the dominant timber type — it covers 92 percent of the commercial forest area.

TIMBER VOLUME

- Sawtimber stands average 7,132 board feet per acre[2] compared with a Rocky Mountain States[3] average of 9,957 board feet per acre.
- Commercial forests contain 6.1 billion cubic feet in sound, live trees; the volume in sawtimber trees is 27 billion board feet.
- Ponderosa pine accounts for 22.9 billion board feet of sawtimber — 85 percent of the total sawtimber inventory.
- Ninety-eight percent of both the cubic-foot and board-foot timber volume is publicly owned.
- Pinyon pine and juniper volume on noncommercial forest land is about 2 billion cubic feet.

STAND CONDITIONS

- The area of sawtimber stands is about equally divided between old growth and young growth.
- About 17 percent of the area of sawtimber stands is less than 40 percent stocked.
- Net annual growth on commercial forest land is 23 cubic feet per acre compared with the average for the Rocky Mountain States of 14 cubic feet per acre.
- Mortality averages less than 6 cubic feet per acre annually. This is the lowest in the Rocky Mountain States, the average for which is 15 cubic feet per acre per year.
- Destructive agents kill 114 million board feet of sawtimber yearly, which is equivalent to one-fourth the gross annual sawtimber growth.

TIMBER USE

- The 1962 harvest of 65.9 million cubic feet amounted to more than 1 percent of inventory. This is the highest cutting rate of any of the Rocky Mountain States.
- Seventy-six percent of the output of timber products in 1962 was used for lumber and 12 percent for pulpwood.
- In 1962 there were 28 active sawmills which produced a total of 326 million board feet of lumber.
- The number of active sawmills dropped from 38 in 1960 to 28 in 1962 and total lumber production fell slightly, but the average annual production per mill rose from 8.7 million board feet to 11.6 million board feet.
- Coconino County was the only county in which more than 100 million board feet of saw logs were harvested.

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[2] *Board-foot volume in saw logs and sawtimber trees is based on International ¼-inch log rule in this report. Lumber volume is based on lumber tally.*

[3] *The Rocky Mountain States are considered to be Montana, Idaho, Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico in this report.*

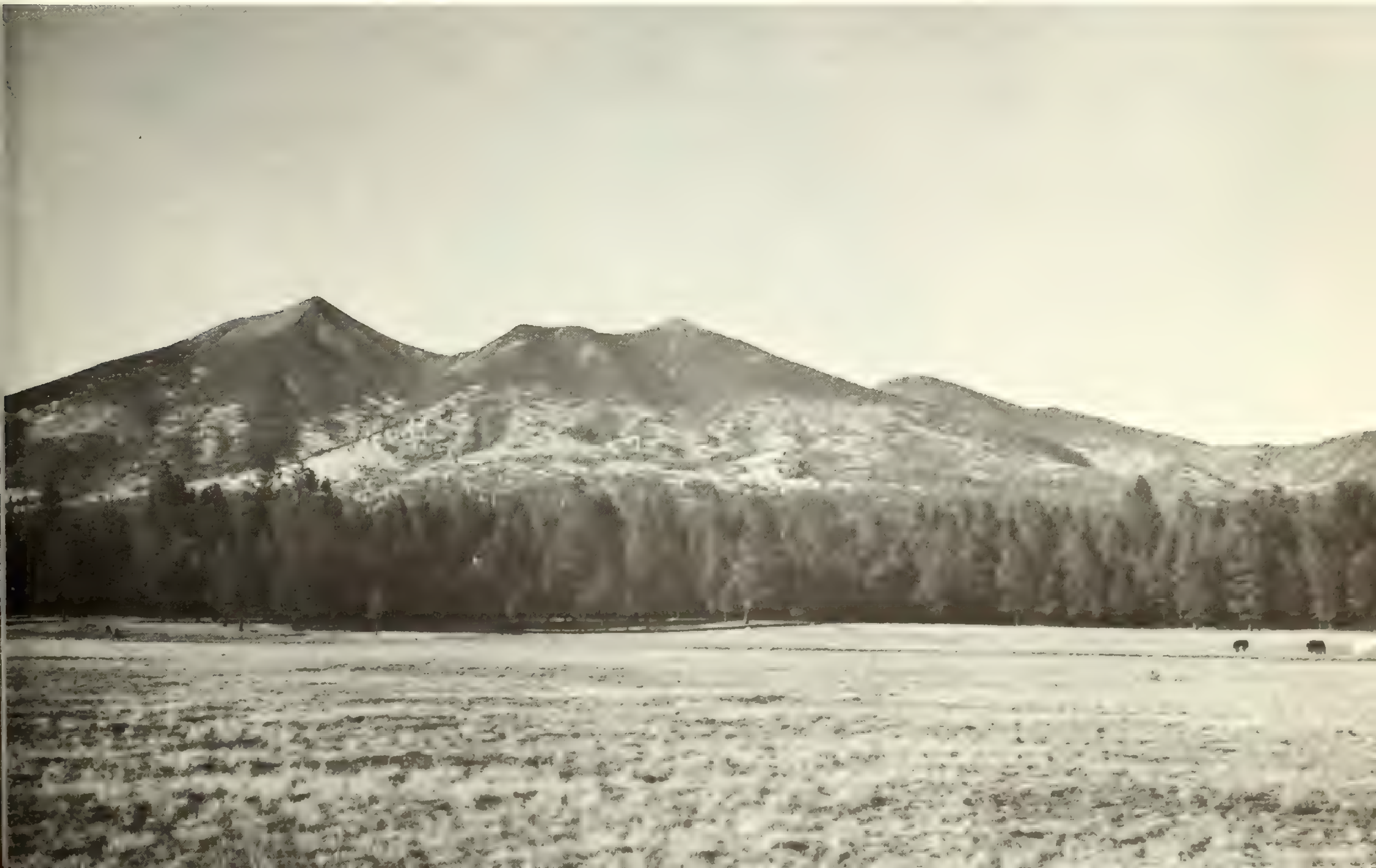
THE FOREST

Arizona's landforms and climate are a study in extremes. They range from the hot, flat desert of the south, on which snow rarely falls, to the 12,670-foot "high place of the snows" as the San Francisco Peaks near Flagstaff were known to the Hopi Indians. North of the desert lie the foothills and low mountains of central Arizona. This rugged topography rises in elevation northward and ends abruptly at the Mogollon Rim, a great escarpment running diagonally in a northwesterly direction across the center of the State. Beyond this rim — romanticized in the writings of Zane Grey as the "Tonto Rim" — the land flattens out to a high plateau that encompasses most of the northern half of the State. Arizona's forests are mostly found in a wide band along the rim.

These forests include 4 million acres of commercial forest land,[4] which contain the most extensive continuous area of ponderosa pine of any State in the country. There are also 17 million acres of noncommercial forest land, which principally produce scrub trees and brush. Besides timber, Arizona's forest lands have important values for water production, recreation uses, and forage for livestock and wildlife. Coronado and his band of conquistadores could only guess at the future significance of these resources in 1540 as they marched through the forests of what is today Arizona.

[4] *Land which is producing or is capable of producing crops of industrial wood and is not withdrawn from timber utilization.*

Forested slopes of the San Francisco Peaks near Flagstaff. Humphrey's Peak — the highest point in the State at 12,670 feet — is the sharp peak on the left. Forest types can be seen in elevational bands. Ponderosa pine at the base gives way to aspen and Douglas-fir in the center of the slope. The fir-spruce type appears as the dark upper band.



Timber types range from about 4,000 to 12,000 feet elevation

The chaparral type[5] begins at an elevation of about 4,000 feet (as shown schematically below). This mixture of scrub oak and brush species blends into the pinyon-juniper type at about 4,500 feet and soon drops out of the stand completely. The ponderosa pine type is first encountered at about 5,500 feet and is displaced at about 8,000 feet by the Douglas-fir type, which is a mixture of Douglas-fir, white fir, quaking aspen, and limber pine. In some areas at this elevation aspen predominates, and such stands are recognized as a distinct forest type. The fir-spruce type, which contains Engelmann spruce, subalpine fir, and cork-bark fir, grows from about 8,500 feet up to timberline (around 12,000 feet). The stratification described above is quite general and local conditions of soil, topography, and climate cause many variations.

The distribution of species is largely determined by precipitation and other climatic influences. Ponderosa pine, sometimes called America's near-desert timber tree, requires at least 19 inches of annual precipitation to grow. In the northern part of Arizona, rain

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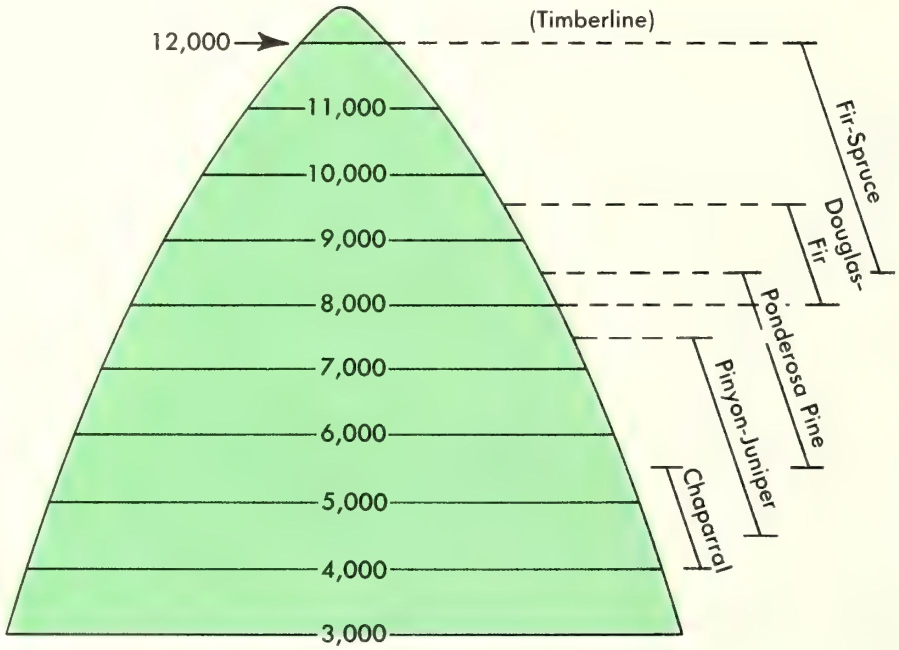
[5] *"Chaparral" as used by Forest Survey is a loose term denoting a variety of brush and shrub species — principally scrub oak, manzanita, sumac, cliffrose, and ceanothus in Arizona. Forest Survey classifies it as a forest type even though the chaparral type does not usually support commercial forest trees.*

GENERAL ELEVATIONAL RANGES OF THE PRINCIPAL FOREST TYPES FOUND IN ARIZONA

(in feet above sea level)



Adapted from "Southwestern Trees – A Guide to the Native Species of New Mexico and Arizona," by Elbert L. Little, Jr.

Junipers, which have been pushed over by bulldozers, are burned in the Beaver Creek drainage of the Coconino National Forest.

and snow provide this amount of water at about 5,500 feet. Similar moisture conditions in the southern portion of the State are found nearly 1,000 feet higher.

Grazing and fire both have had their effects upon species distribution too. Past overgrazing and the resulting destruction of grass cover appear to have enabled ponderosa and pinyon pines and juniper trees to become established on some former grasslands. Before organized fire control efforts were initiated, frequent wildfires created openings in pinyon-juniper stands. Temporary communities of grass grew on these sites and were later replaced by trees. Now, however, with better protection the area of pinyon-juniper has tended to increase at the expense of grasslands because of the ability of the trees to dominate understory plants (Arnold et al. 1964).

About four-fifths of the forest area is classed as noncommercial

About 16.6 million acres or 81 percent of Arizona's forest are classed as noncommercial — mostly lands that are not suitable for commercial timber production. Three-fourths of this area is owned by the public. National Forests and Indian lands together account for 66 percent of the total noncommercial area.

About 353,000 acres are classed as commercial, but are reserved from timber harvesting and are therefore considered noncommercial. Some of these reserved lands lie within Grand Canyon National Park, Lake Mead National Recreation Area, and National Monuments; others are in primitive, wild, and wilderness areas within National Forests.

The bulk of the noncommercial forest area — the chaparral and pinyon-juniper types — is found in the dry lower limits of the forest where precipitation is not sufficient to support commercially important species. Some areas of other types occur within the commercial zone on patches of shallow soils or otherwise harsh sites where tree growth and quality are minimal. Almost three-quarters of the noncommercial forest consists of pinyon-juniper woodlands. This type covers more than 12 million acres in Arizona — three times the area of commercial forests in the State. This constitutes 17 percent of the total land area in the State. Nearly 4 million acres of chaparral and about 0.6 million acres of ponderosa pine, Douglas-fir, fir-spruce, and other types complete the noncommercial forest area.

Pinyon pine trees on noncommercial forest land contain an estimated 953 million cubic feet of wood, and junipers total about 1,040 million cubic feet. Some forest products — Christmas trees, fenceposts, fuelwood, and pinyon nuts — are harvested from these lands. However, demand for most of these products is small. Extremely slow growth rates, small tree size, poor form, high cost of harvesting wood, and a shortage of markets for wood products are factors that tend to discourage timber management on pinyon-juniper lands.

These woodlands are more important for forage than for timber even though forage yields per acre are low in the pinyon-juniper type. Demand for grazing land is high. Although sparse, the grasses that grow in pinyon-juniper stands are valuable feed for domestic livestock. Forage production is slim in these stands. Grasses are forced out by the trees because pinyon pines and junipers are better able to compete for the limited soil moisture. For this reason, many land managers have begun to remove these trees on both public and private woodlands by cabling, bulldozing, and/or fire and to replace them with perennial grasses. Between 1950 and 1961, more than 1 million acres of pinyon-juniper lands were cleared in Arizona (Arnold et al. 1964).

An intensive survey, designed to classify the 12 million acres of pinyon-juniper woodland into potential use categories, would be useful in determining which of these lands should receive treatment. A classification of this type is advisable because the removal of pinyon-juniper trees has significant effects on other resources.

Increases in forage production following pinyon-juniper removal are well documented. These have ranged from 200 to nearly 700 pounds (dry weight) of herbage per acre. However, the effects of this land treatment on big game food and cover, soil erosion, and water yields are not as well known. Studies are underway to learn more about these relationships.

The commercial forest is almost all publicly owned

Nearly all the commercial forest area (96 percent) and timber volume (98 percent) are in public ownerships — principally National Forest. The 4 percent in private holdings is the smallest proportion of privately owned commercial forest land area of any State except Alaska. The Rocky Mountain States average for commercial forest land in private ownership is 23 percent. Ownership distribution in Arizona is as follows:

	Thousand acres	*Million cubic feet*	*Million board feet*
National Forest	**2,630**	**4,389**	**19,153**
Indian	**1,144**	**1,533**	**7,218**
Bureau of Land Management	**2**	**(1)**	**1**
State	**32**	**22**	**74**
County and municipal	**2**	**1**	**4**
Farmer	**82**	**87**	**299**
Miscellaneous private	**85**	**59**	**202**
Total	**3,977**	**6,091**	**26,951**

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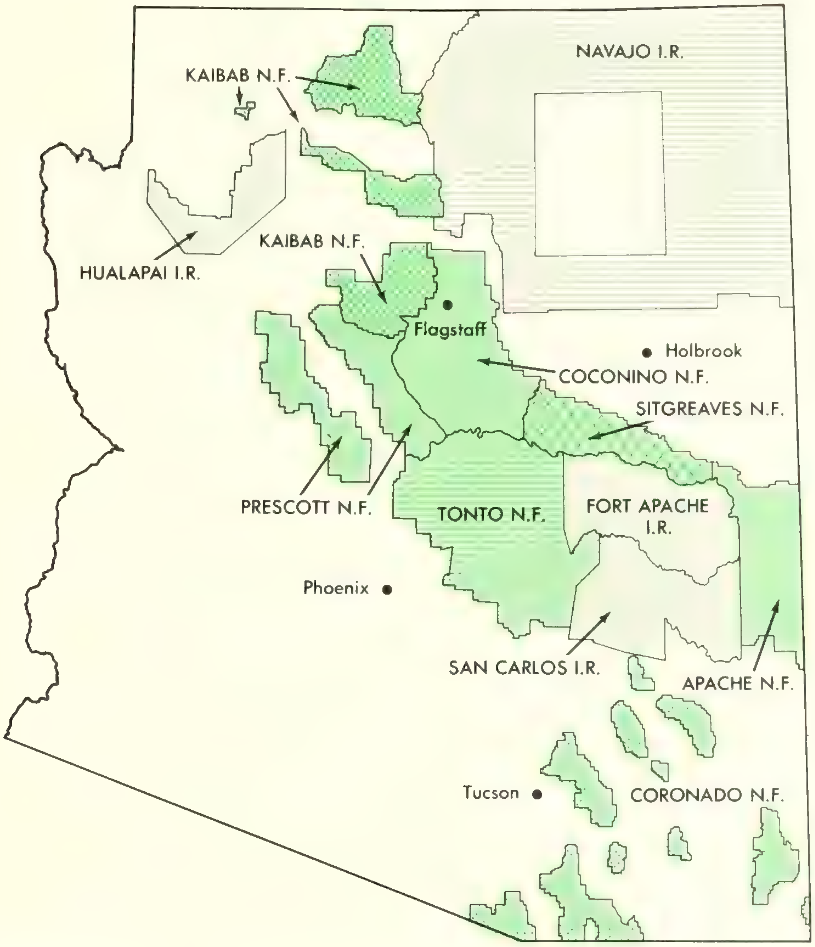
[1] *Less than 500,000 cubic feet.*

Accordingly, most of the harvest of timber products is on public lands. A report by Wilson (1964) on the 1962 output of timber products in Arizona shows the following distribution of yield by land ownership classes:

	Percent
National Forest	**69.3**
Other public	**21.6**
Private	**9.1**
Total	**100.0**

The lands that comprise Arizona's seven National Forests were set aside from the public domain between 1898 and 1908 to

NATIONAL FORESTS AND PRINCIPAL TIMBERED INDIAN RESERVATIONS IN ARIZONA



preserve watershed and timber values on these areas. The Prescott was the first National Forest established in the State. Most National Forests are found in the high plateau, foothill, and mountainous country of central Arizona. One, the Coronado, consists of scattered stringers in the short mountain chains of the southeastern corner of the State. The Apache and Coronado National Forests extend into New Mexico. Indian lands comprise 29 percent of the States' commercial forest area. Practically all of this area is found on the four Reservations shown in the map above — the Navajo, Fort Apache, San Carlos, and Hualapai. There are other Indian Reservations in Arizona, but none contain significant amounts of commercial forest land. The Fort Apache and Navajo Indian Reservations are the most important, with 63 percent and 25 percent of the total Indian commercial forest land, respectively. Indian Reservation lands are under Federal trusteeship and are managed by the Bureau of Indian Affairs.

Most of the commercial forest area is in sawtimber stands

Sawtimber stands dominate the commercial forest, constituting 94 percent of the area! No other State has such a high proportion of sawtimber stands: the average for the Rocky Mountain States as a whole is only 59 percent while the average is much less for the United States (41 percent).

The area of sawtimber stands is divided almost equally between old growth stands (about 2 million acres) and young growth stands (about 1.8 million acres). The former are generally over 120 years old. In volume, sawtimber stands total about 6 million cubic feet or 26.7 million board feet. The remaining 6 percent of the commercial forest area is classed by area and volume as follows:

	Thousand acres	*Million cubic feet*	*Million board feet*
Poletimber stands	**128**	**136**	**238**
Sapling and seedling stands	**41**	**5**	**16**
Nonstocked areas	**65**	**1**	**3**
Total	**234**	**142**	**257**

Nearly one-half the sawtimber stands in the State have less than 5,000 board feet per acre. The average volume per acre in sawtimber stands in Arizona is only 7,132 board feet[6] compared to an average of 9,957 board feet for the Rocky Mountain States.

Approximately 41 percent of the commercial forest area is well stocked, while only 17 percent is either poorly stocked or nonstocked. These figures, however, fall short of giving an adequate picture of how well the land is being used by trees. Actually, many of the young stands that are classed as well stocked are overstocked to the point of stagnation. Unless overstocked stands are thinned while they are still young and vigorous enough to respond to better growing conditions, they will yield no appreciable volume of sawtimber. There is also evidence that only a minor portion of the area that is considered well stocked with live trees (including cull trees) has an adequate number of desirable trees. The latter are the healthy, vigorous, and well-formed trees that forest managers try to grow and feature in management.

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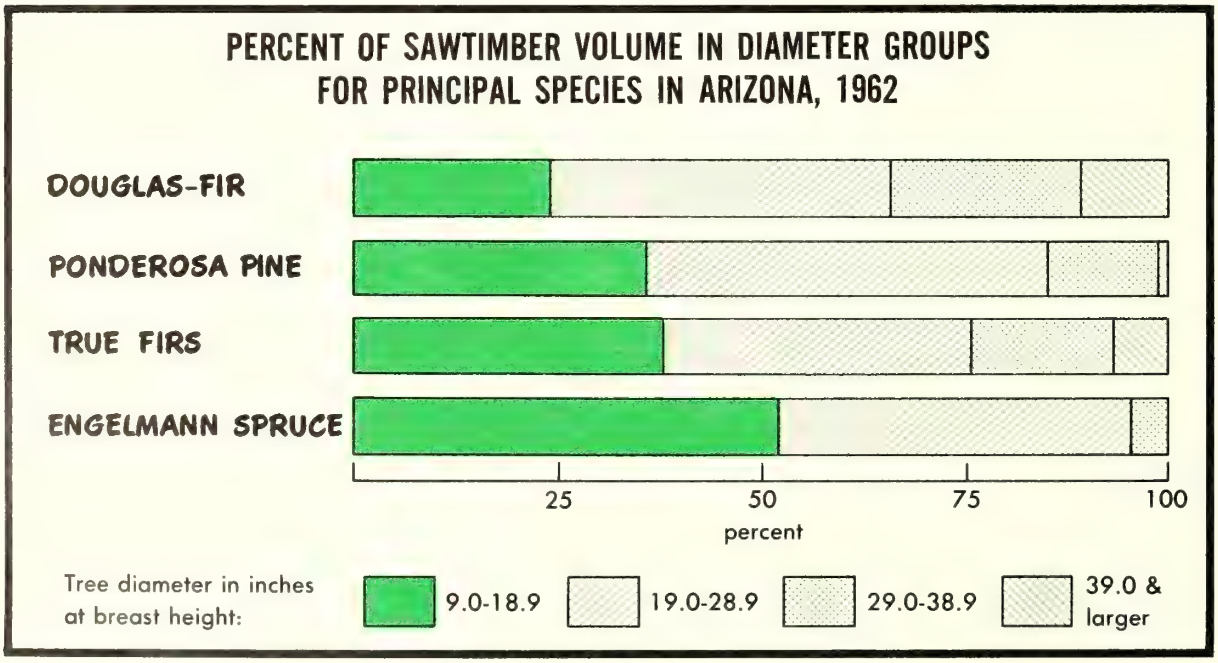
[6] *Includes volume of all sound, live softwood trees 9.0 inches and larger and hardwood trees 11.0 inches and larger in diameter at breast height (d.b.h.).*



Of the nearly 27 billion board feet of sawtimber in Arizona, 85 percent is ponderosa pine. Douglas-fir (5 percent), Engelmann spruce (5 percent), and true firs (3 percent) account for most of the remaining sawtimber volume. Practically all this volume is found in sawtimber stands.

As shown in the chart at left, the bulk (64 percent) of the sawtimber volume is in trees 19 inches in diameter and larger. Seventeen percent is in trees 29 inches in diameter and larger.

Site index[7] is indicative of the height that the taller trees in a stand can attain at a certain age. The percentage distribution by area of Arizona's ponderosa pine type according to site index classes is as follows:

Site index class	*Percent of area*
40	7
50	20
60	33
70	24
80	11
90	3
100	2
Total	**100**

Growth rate is highest of Mountain States, but is far short of potential

Net annual growth in the commercial forest averages 23 cubic feet per acre compared to the Mountain States average of 14 cubic feet per acre. Part of the reason for Arizona's comparatively high net growth rate is the extremely low rate of tree mortality (mortality is subtracted from gross growth to determine net growth). Less than 6 cubic feet per acre is lost annually to mortality. This is the lowest of the Rocky Mountain States, the average for which is 15 cubic feet per acre per year.

The principal reason for Arizona's low mortality rate is that mature trees have been harvested before they died. This resulted from the widespread selective logging in the past made possible by the State's relatively accessible timber stands. Arizona's overmature stands, consequently, are not as decadent as old growth stands in most of the other Rocky Mountain States. This is important because 52 percent of the State's sawtimber stands is classed as old growth.

Although Arizona's present net growth rate is impressive when compared with other Rocky Mountain States this is still only roughly one-half of its potential yield. The inherent capacity of the State's commercial forest lands to grow wood is estimated to average 43 cubic feet per acre per year.[8] Yield is the volume of wood that could be grown every year if all stands had an optimum distribution of age classes and were fully stocked and adequately protected. Because these ideal conditions do not exist presently, and probably will not exist for a long time, potential yield remains a goal toward which forest managers aim.

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[7] *Site index is the height in feet of average dominant and codominant trees at a specified age (100 years for ponderosa pine). For example, "site index 60" for ponderosa pine means that the height of dominant and codominant trees in the area average or will average 60 feet in 100 years.*

[8] *Estimate developed for ponderosa pine by relating measurements of height and age of sample dominant and codominant trees to yield information shown in U. S. Dep. Agr. Tech. Bull. 630, "Yield of even-aged stands of ponderosa pine," by Walter H. Meyer, 1938, rev. 1961. Yields correspond to the mean annual growth of sound, live trees 5 inches d.b.h. and larger (not including thinnings) attainable in fully stocked stands at culmination of mean annual increment. The average estimate of 43 cubic feet per acre per year for the entire commercial forest is based on the assumption that potential yields of all species are the same as for ponderosa pine and is probably a conservative estimate.*

The area of commercial forest land within productivity classes and the estimated potential yield of all sound, live trees from each are shown below:

Productivity class	Area		Estimated potential yield
Cubic feet per acre	*M acres*	*Percent of total*	*M cubic feet*
85-120	56	1	5,748
50-85	880	22	59,405
20-50	3,041	77	106,424
Total	3,977	100	171,577

The total potential annual yield of sawtimber is estimated to be 617 million board feet or 169 board feet per acre. The above potentials will be pushed even higher to the extent that trees are harvested before they are lost through mortality. Sawtimber yields can be increased beyond the potentials cited above by thinning and other cultural work that will improve size and growth of trees.

Large areas, such as northern Idaho and western Montana, undoubtedly have much higher potentials than Arizona, but no reliable comparisons can be made until better data are available for these areas.

Destructive agents kill 114 million board feet of sawtimber a year

Nearly 114 million board feet of sawtimber trees are killed annually by disease, insects, fire, vertebrate animals, and other agents. This volume is equivalent to 25 percent of the gross growth of sawtimber. In addition, some of these destructive agents cause a reduction in growth rates and sometimes in tree quality. This retarding effect on tree growth is a big factor in holding down net growth of the forest.

Among the many diseases which attack forest trees in Arizona, dwarfmistletoe has the most damaging effect. This parasite is found principally on ponderosa pine and Douglas-fir and is widespread throughout their ranges. A recent survey in Arizona and New Mexico (Andrews and Daniels 1960) found dwarfmistletoe present on 36 percent of the plots examined in the ponderosa pine type and on nearly one-half the Douglas-fir plots. In Arizona, dwarfmistletoe was found to be most abundant on the Apache National Forest and the Fort Apache Indian Reservation. It is also severe on the Coconino, Kaibab, and Sitgreaves National Forests, and to a lesser extent on the Navajo Indian Reservation.

The survey mentioned above found infection in ponderosa pine to be more abundant as well as more severe in virgin than in cutover stands. Lightly infected virgin ponderosa pine stands averaged 6,620 board feet per acre compared with 5,470 board feet per acre in moderately infected stands — a 17-percent reduction in yield.

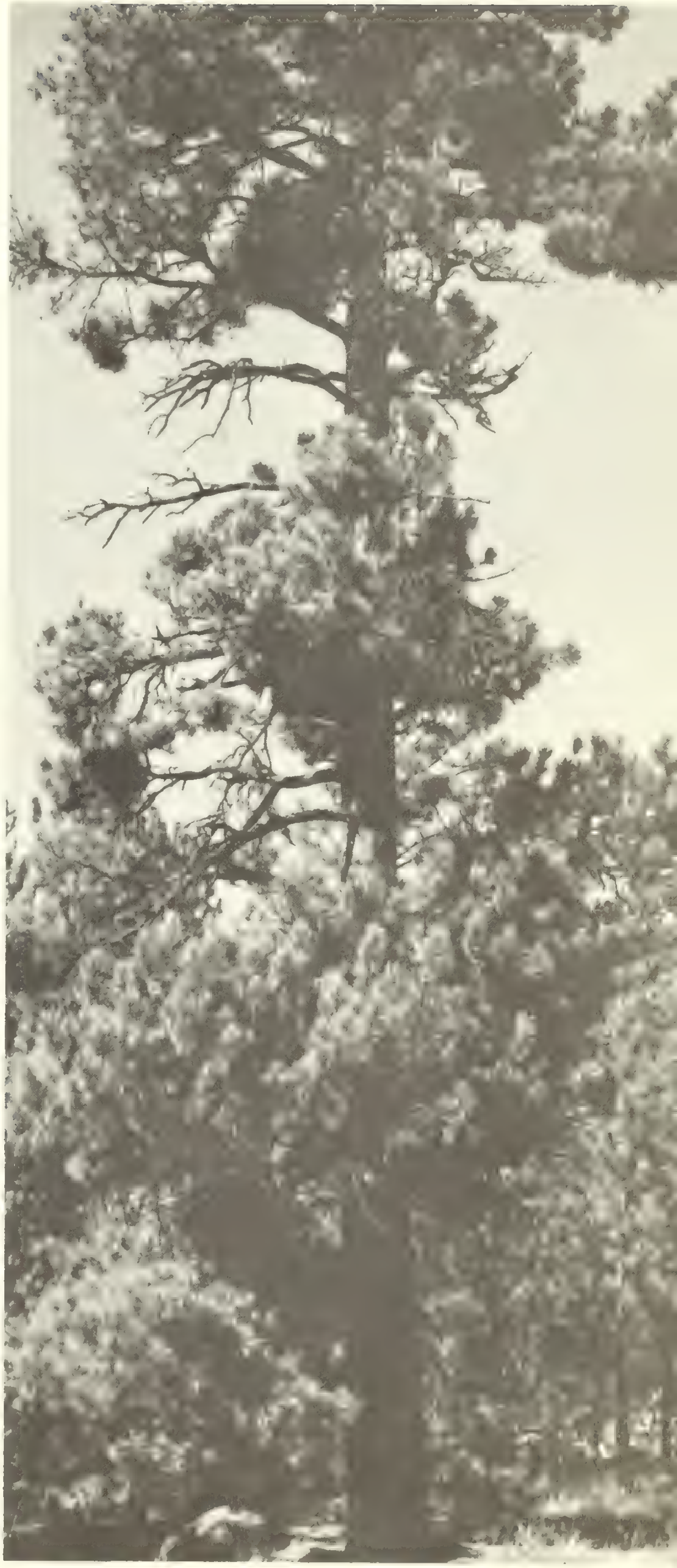
Western red rot is another damaging disease in Arizona's ponderosa pine forests. This fungus-caused heart rot is by far the greatest single cause of the 20 percent or more cull that is commonly found in virgin stands (Pearson 1950). The disease is found principally in trees over 150 years old. Red rot probably will become less prevalent as these stands are brought under management and most trees are harvested at ages less than 150 years.

Other diseases are of less economic importance although one, a species of root rot, has the potential for being the most destructive of all diseases in ponderosa pine stands. Paintbrush blister rust kills ponderosa pine trees and also reduces growth. Needle blights slow the growth of Douglas-fir, and aspen is afflicted with stem cankers. Broom rusts are destructive in the fir-spruce type.

Although losses from insects could be extreme in Arizona — a State dominated by one tree species — there is relatively little damage at present. This is partly attributable to the extensive logging of the past that accounts for the general absence of widespread areas of decadent, overmature timber.

Among the insects that are currently active, bark beetles cause most of the damage.

Growth rates are diminished by these insects and severe attacks result in death of the trees. Control efforts generally include salvage logging and disposal of slash to prevent further insect population buildups. One bark beetle, the Douglas-fir beetle, causes significant loss in Douglas-fir throughout the State — especially on the Kaibab National Forest. New outbreaks of the Arizona five-spined ips occurred on the Prescott National Forest in 1964 and killed ponderosa pine in a heavily used recreation area. The white fir needle miner, previously unrecorded in the Southwest,[9] damaged several thousand acres of white fir stands on the Kaibab Plateau during 1964. Aspen was defoliated by the Great Basin tent caterpillar in small areas over northern Arizona during the same year.



Severe infection of dwarfmistletoe on a ponderosa pine in the Coconino National Forest. Dead branches and holes in the crown of the tree shown above indicate reduced vigor and growth. "Witches brooms," such as those seen here, are also characteristic and cause the tree to grow stouter limbs to support them. This results in larger knots in lumber sawn from infected trees.

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[9] *In this report the Southwest includes Arizona and New Mexico.*

Ponderosa pine stand of mixed-age classes on the Fort Apache Indian Reservation. The old-growth trees in the background average 20 inches d.b.h. and about 70 feet tall. The seedlings and saplings in the foreground range from 3 to 5 feet tall. Large poles and young-growth sawtimber are largely missing in this part of the stand. The area of these two stand-size classes is rather small over much of Arizona.

Ponderosa pine dominates the commercial timber resource

Ponderosa pine predominates on 3,657,600 acres or 92 percent of the State's commercial forest land. It grows in many areas of the State, but the bulk of the type is found on the Mogollon Plateau in central Arizona where it grows as an unbroken stand for nearly 225 miles. Apache pine, Chihuahua pine, and Arizona pine replace ponderosa pine in the mountains of the extreme southern portion of the State. These species, which closely resemble ponderosa pine, are grouped with ponderosa pine in this report. Douglas-fir, Gambel oak, limber pine, and pinyon pine are the species usually associated with ponderosa pine.

In the Southwest, ponderosa pine is usually classed into two broad categories — blackjack and yellow pines. The former, usually less than 150 years in age, have dark bark and relatively rapid taper. After a rain the bark appears nearly black until it has dried — hence the name. Yellow pines, on the other hand, usually exceed 150 years in age and have yellowish bark, often in broad, flat plates. Their crowns are usually rounded, indicating that full height growth has been reached.

There is about 22.9 billion board feet of ponderosa pine sawtimber in Arizona, which is 85 percent of all the sawtimber on commercial forest land in the State. About one-half of the area of ponderosa pine sawtimber stands is old growth; i.e., more than 120 years old.

Since 1869, about 95 percent of the lumber sawed in Arizona has been ponderosa pine. There are no records to indicate that lumber of any other species was produced until 1899 (Steer 1948). In 1962, ponderosa pine accounted for 279 million board feet or 86 percent of the State's lumber production and about 80 percent of the total roundwood harvest. The continued heavy use of ponderosa pine is partly due to the easy accessibility of many pine stands. In addition, the wood produced by this species is among the best for all-around use. Intermediate grades of lumber are used for framework, sheathing, and subflooring, the better grades for siding, and the highest grades for window sash, doors, and interior finish. All the pulpwood produced in Arizona during 1962 — nearly 8 million cubic feet — was ponderosa pine. Railroad ties, mine timbers, and utility poles are other products made from ponderosa pine.

Recreation use is heavy in the ponderosa pine type. Cattle and sheep grazing is also important in this type, especially in openings and meadows within the timber.

As mentioned in the caption on the opposite page, intermediate size classes — large pole and young-growth sawtimber stands — are present in less than desirable numbers over much of the ponderosa pine type. Poletimber stands of all forest types represent 3 percent of the commercial forest area — about 128,000 acres. This uneven distribution of area of size classes complicates timber management planning. More intermediate-sized trees, which are presently in short supply, are needed to insure that a sufficient number of merchantable-sized trees is available in the future to maintain the current level of cutting of ponderosa pine. Thinnings are being made over wide areas to accelerate the growth rates of saplings and small poles and move these trees more rapidly into the larger size classes.

Stand of Douglas-fir small sawtimber at an elevation of 8,500 feet on the Apache National Forest. These trees average 80 feet in height and are mature.

Douglas-fir covers the second largest area among timber types

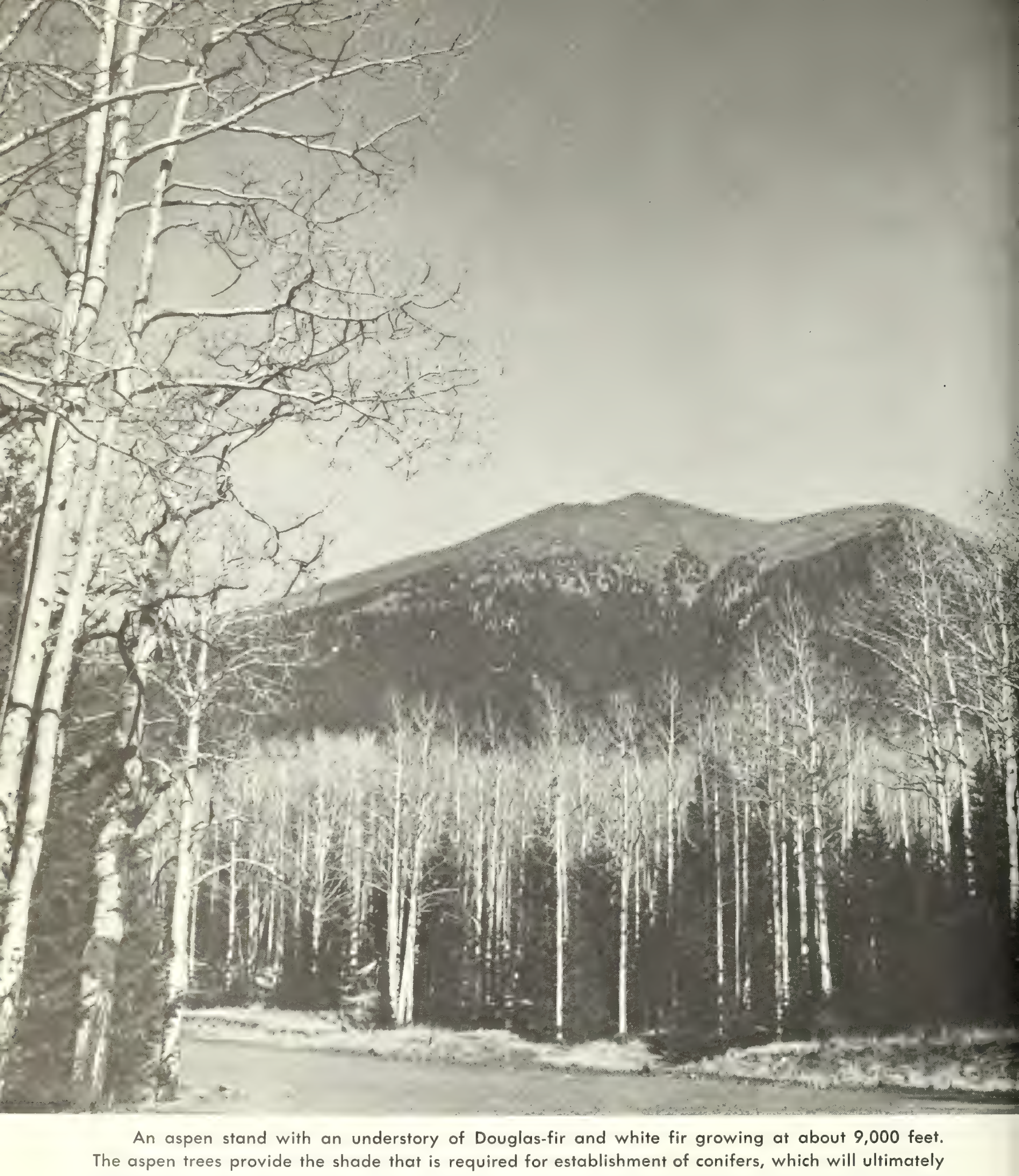
The Douglas-fir type predominates on 129,900 acres (about 3 percent of the commercial forest). This type is found principally on scattered locations in northern Arizona—in the White, Chuska, and San Francisco Mountains, and on the Kaibab Plateau. The forest-type map in the Appendix does not show a Douglas-fir type because the map scale does not permit areas so small to be shown. This type generally is found in a band between the ponderosa pine and fir-spruce types. All of it is in public ownership.

Several different species make up this type. Although Douglas-fir is the predominant species, white fir accounts for most of the volume in some stands. Engelmann spruce, subalpine fir, limber pine, ponderosa pine, and quaking aspen are also found in this type.

Practically all of the type is in sawtimber stands. Less than 500 acres are classed as either poletimber or sapling-seedling stands. The volume in uncut sawtimber stands varies greatly but it probably averages about 15,000 board feet per acre (Krauch 1956). There are large areas of Douglas-fir in old-growth, decadent stands as evidenced by the estimate that annual mortality of Douglas-fir exceeds growth by nearly 12 million board feet. This is largely due to the fact that there has not been much logging in this relatively inaccessible type until recent years. Since the earliest logging of Douglas-fir lands (about 1900), slightly more than 3 percent of the lumber produced in Arizona has been Douglas-fir. In 1962, however, Douglas-fir accounted for 7.2 percent of the lumber sawn. Douglas-fir is used for lumber, flooring, railroad ties, and mine timbers.

The Douglas-fir type is highly important as a protective cover for watersheds. This type grows on a substantial portion of the most rugged mountainous country from which most of Arizona's surface water supply originates, primarily from snowmelt.

The Douglas-fir type, which is found in high country, is used extensively for recreation. Many summer homes are built there and some of the best big game hunting and winter sports areas are in this forest type.



An aspen stand with an understory of Douglas-fir and white fir growing at about 9,000 feet. The aspen trees provide the shade that is required for establishment of conifers, which will ultimately replace the aspen unless fire or other destructive agents alter this natural plant succession. The photo also shows an area of the fir-spruce type higher up on the slopes of Humphrey's Peak, tallest of the San Francisco Peaks, on the Coconino National Forest.

Untapped aspen resource fills other vital needs

The aspen type covers about 79,000 acres, or 2 percent of the commercial forest in Arizona. This species generally is found on most of the same sites as Douglas-fir, although it extends into both ponderosa pine and fir-spruce types. It grows best on moist sites and frequently occupies natural drainage channels and the toes of slopes. The aspen type is a temporary cover on some lands—it usually becomes established after fire or logging and is later invaded by conifers. A large proportion of the present aspen stands on Mt. Baldy in the White Mountains developed after extensive fires in the early years of this century (Arizona Watershed Program Staff 1956).

The area of commercial aspen type is about equally divided between sawtimber and poletimber stands — 46 percent and 49 percent respectively. Only 5 percent is classed as sapling and seedling stands. Seventy percent of this type is publicly owned, but the 24,000 acres of privately owned aspen represent 14 percent of all commercial forest in private ownership.

Aspen wood has many desirable properties, but its use in Arizona has been minor and limited principally to production of excelsior and fuelwood. Practically no lumber has been produced from aspen. It could become a significantly important source of fiber if interest in pulping the species develops.

However, the aspen forest is important in a number of other ways. Its value as a watershed-protecting cover is high and it is considered an important soil-building type. The aspen suckers and associated vegetation that usually develop rapidly and abundantly following fire or heavy cutting are valued forage for domestic livestock and big game animals. The aspen forest also provides a nurse crop under which commercially important species can become established. Aspen trees are outstanding esthetically, and many recreation areas are dominated by them. Their well-known, golden fall foliage is enjoyed by many, some of whom get no closer to the forest than an occasional Sunday drive.

Fir-spruce type at about 10,000 feet in elevation near Snow Bowl Winter Sports Area on the Coconino National Forest. These young growth sawtimber trees average 12 inches d.b.h. and 70 feet in height.

Timberline location obstacle to utilization of fir-spruce type

The fir-spruce type grows at higher elevations than any other commercial forest type in Arizona. It is found just below timberline and constitutes 3 percent of the commercial forest area, or 110,300 acres. Engelmann spruce, subalpine fir, and corkbark fir are characteristic of the type, although Douglas-fir, white fir, and aspen are fairly common. All of this type is publicly owned. All but about 1,000 acres of the fir-spruce type is in sawtimber stands. Engelmann spruce makes up 5 percent (1.2 billion board feet) of the State's sawtimber volume and the true firs[10] 3 percent (0.9 billion board feet).

Until the late 1940's, only a negligible amount of lumber was produced in Arizona from either spruce or the true firs. Since then, the volume of lumber produced from these species has increased rapidly. However, it still represents a minor part of the State's output. In 1962, the nearly 18 million board feet sawn from true firs and 5 million board feet sawn from Engelmann spruce represented less than 6 percent and 2 percent, respectively, of all lumber produced in Arizona.

The fir-spruce forest grows on the most inaccessible sites and on the most rugged topography within the commercial forest. Road construction is difficult and expensive under these conditions. These are the primary reasons why the fir-spruce type has not been harvested extensively.

Water yields are greater in the fir-spruce forest than in any other forest type because the greatest precipitation falls at the higher elevation. Annual precipitation in this type averages 30 to 35 inches of water, 60 percent of which is from snow. This compares with the annual precipitation in the ponderosa pine type of about 19 to 25 inches of water. The watershed protection value of the fir-spruce forest is understandably high.

Fir-spruce lands provide important summer range for big game and also offer recreational opportunities for high altitude lake and stream fishing, as well as winter sports.

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[10] *White, subalpine, and corkbark firs.*

THE FOREST IN USE

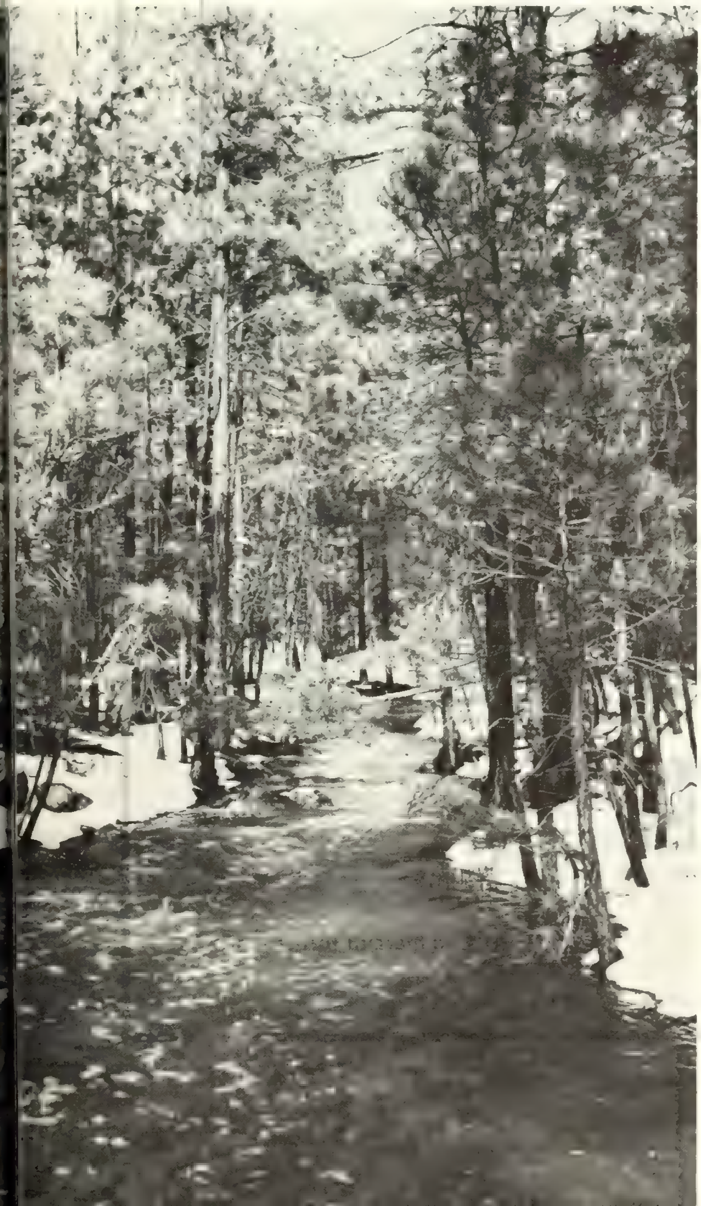
Arizona's 21 million acres of forest lands have been used ever since there has been someone to use them. Primitive Indian tribes made use of products from the forest as did the Spanish explorers and missionaries and, later, the American mountain men and settlers. Then, as now, these forests had more than one use. Today people in the parched lowlands rely heavily on water produced in the forested high country. Many acres within the forest provide forage and browse for livestock and wildlife. Trees have been felled and used from much of the commercial forest. Almost all of the forest is open to the public for a wide variety of outdoor recreation.

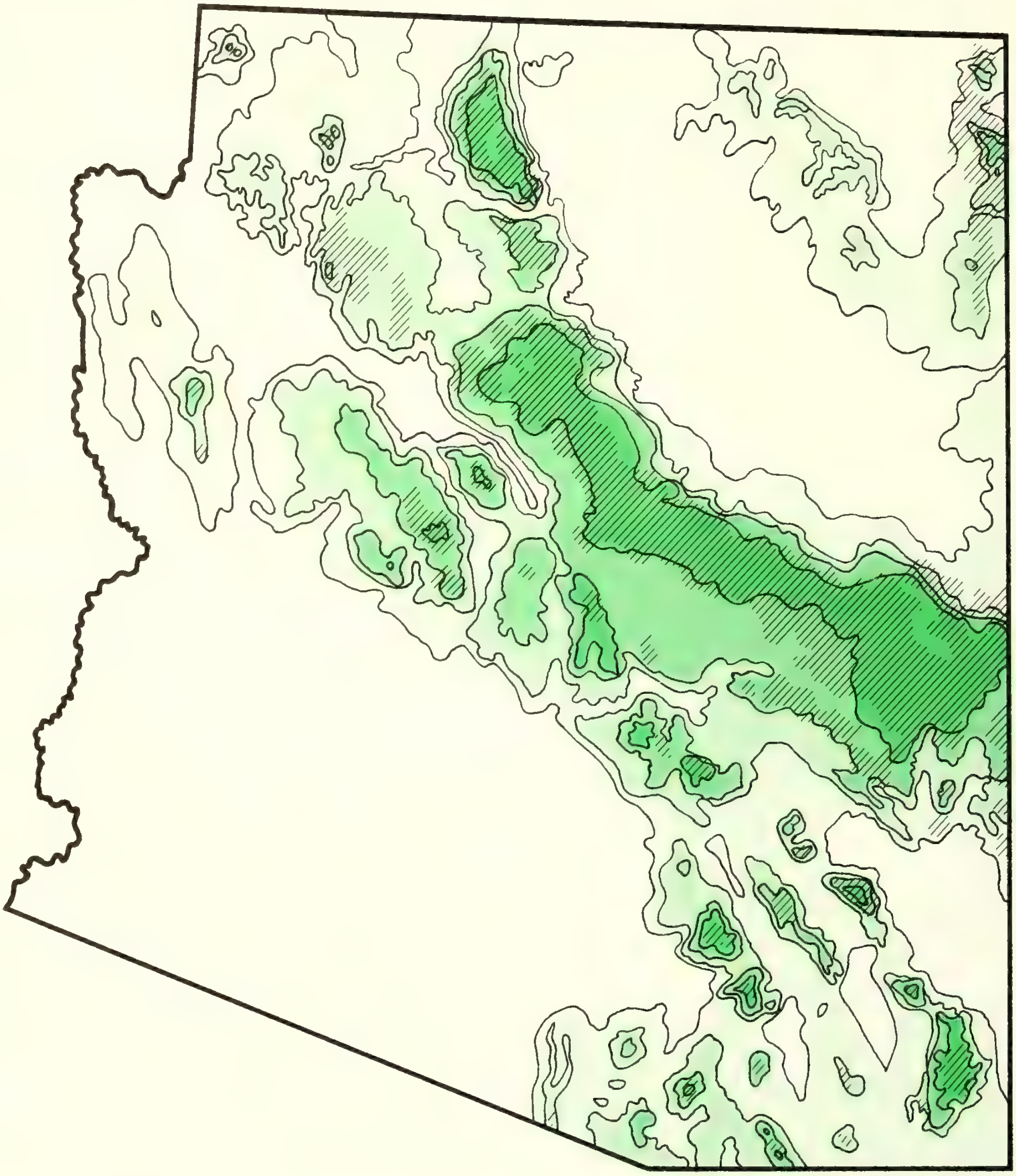
Below is a view of the Apache National Forest taken from near the top of Baldy Peak in the Mt. Baldy Primitive Area. The second highest peak in Arizona (11,590 feet), Baldy Peak provides visitors a unique perspective of the timber, lakes, streams, meadows, and grassy openings found on the surrounding slopes. The dynamic plant and animal community that makes up the forest presents challenging problems to land managers who are charged with planning wise resource use.

Forest runoff plays critical role in meeting State's increasing water needs

The rapid burgeoning of Arizona's population and economy and the resulting strident demands for more water attach particular importance to the State's forested watersheds. Water from the forests has always been vital to the very existence of people in the arid lowlands. This is indicated by remains of ancient irrigation canals used by the Hohokam Indians to wrest a living from the desert near Phoenix about 200 B.C. Irrigation has traditionally consumed far more water than any other use. Even today, agriculture accounts for about 95 percent of the estimated 6.6 million acre-feet of surface and ground water consumed annually in the State (U. S. Senate 1960). Now, however, increasing amounts are needed for urban and industrial uses. Between 1950 and 1960, Phoenix's population quadrupled and Tucson's increased nearly five times. As a result, the rate of water use by municipalities and industry is increasing about eight times faster than that of crop irrigation. Today, the State's need for water is critical, and future growth is largely dependent on the availability of water.

Runoff from melting snow in the ponderosa pine type swells Beaver Creek on the Coconino National Forest (left). Nearly all surface water flows are impounded in Arizona and are serving some useful purpose such as irrigation (right).





AVERAGE ANNUAL RUNOFF — ARIZONA

(in inches of water)

🟩 over 2
🟩 1- 2
🟩 .5- 1
□ .1-.5
□ less than .1
▨ Commercial forest land

Based on an unpublished map by J. H. Dorroh, Jr., Soil Conservation Service

Arizona's forest lands play a big role in providing water to the consumer. Much of the 2.1 million acre-feet of surface water consumed annually originates within the State as runoff from the relatively high water-yielding forest.

In general, precipitation and resulting water yields per acre are greatest for forest types at high elevations. The Forest Service in the Southwestern Region made the following conservative estimates of water yield by forest types on National Forests:

Forest type	Average annual runoff[1]
	Inches
Fir-spruce and Douglas-fir	**4.7**
Ponderosa pine	**2.8**
Pinyon-juniper	**1.1**
Average[2]	**1.7**

About 80 million acre-feet of precipitation fall annually in Arizona (U. S. Senate 1960). Of the large amount of this water used and then transpired into the atmosphere by plants, approximately 4.2 million acre-feet are used by timber and forage crops alone. If research can point the way toward better use of a portion of this water, the contribution to Arizona's economy will be invaluable.

An important part of present research is the work being done to determine the effects of various kinds of land treatment practices on water yield and other resource uses. Such practices as converting pinyon-juniper and ponderosa pine stands to grass, intensive thinning of ponderosa pine, clear-cutting pine and fir timber in moist stream bottoms, and prescribed burning of chaparral and ponderosa pine show promise for increasing water yield. However, the same population increase that has brought greater demands on the water resource has brought greater demands on other resources as well. Recreation, timber, and forage uses of the forest also will be affected by vegetative manipulation. Land managers must consider these values, too, and weigh carefully the advantages and disadvantages to each resource.

Modern range management replaces destructive overgrazing of past

Livestock have grazed intermittently on Arizona's forest range since 1540 when Coronado brought with him 1,000 horses, 500 cattle, and 5,000 sheep. Before that, deer, elk, bear, and antelope found forage and browse on these lands — principally chaparral, pinyon-juniper, and ponderosa pine lands. Spanish missions became livestock centers about 1700 and by 1880 large cattle companies began intensive use of the range. Following recovery from the depression of 1873 the cattle industry expanded rapidly and by 1883 the number of livestock brought into the State had reached large proportions. Ranges that for permanent and regular use would have been overstocked with one cow to every 100 acres were overloaded until they carried one cow to every 10 acres.

The attendant overgrazing from this unrestricted use of the range had disastrous effects. Starvation of cattle on the depleted ranges followed the drought years of 1893-94. It was estimated that over 250,000 cattle out of about 800,000 perished on the Arizona range during the period 1891-94 (Thornber 1910). Much of the thin layer of topsoil on grazed lands was lost through sheet and gully erosion, and with it the ability of the range to produce maximum yields of forage. Also, overgrazing may have favored expansion of the pinyon-juniper type.

The establishment of the National Forests and government controls on the public domain brought a degree of stability to the livestock industry. Figures on the number of livestock permitted to graze on the National Forests of Arizona are indicative of

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[1] *Runoff estimates made by George D. Hardaway of the Regional Forester's staff, U. S. Forest Service, Southwestern Region, Albuquerque, New Mexico.*

[2] *Average weighted according to area of forest types.*

Cattle grazing on forest range in the Apache National Forest. Livestock must be fenced out of forest plantations until the young trees are no longer susceptible to browsing damage. This is a necessary action if grazing and timber use of the forest are to remain compatible.

the trend of use since 1910. These data show that cattle numbers peaked during World War I when the demand for meat intensified range use. The 367,000 cattle on National Forest ranges in 1918 thinned to 141,000 in 1963 — a decline of 62 percent. Sheep, which were brought into the State in large numbers after the collapse of the cattle boom, reached a peak on the National Forests in 1912. In that year there were 454,000 sheep — nearly eight times as many as the 57,000 permitted in 1963.

Grazing practices have improved measurably since the days of unrestricted range use. Present livestock use of the forest range involves consideration of timber, water, recreation, and wildlife values of the land. Considerable effort has been put into rehabilitating depleted ranges and in making others more productive. The Bureau of Land Management, the Bureau of Indian Affairs, and the Forest Service — the principal administrators of the public range — all have programs of range improvement which benefit both livestock and wildlife. In 1963, for example, the Forest Service seeded nearly 26,000 acres to desirable grasses and eradicated undesirable plants on another 18,000 acres in Arizona's National Forests. During the same year, 270 miles of range fences and 191 stock ponds and reservoirs were constructed to permit better distribution of livestock. Much of this work was accomplished as a cooperative effort between the grazing permit holder and the Forest Service. Projects to improve wildlife habitat are sometimes undertaken jointly with the Arizona Game and Fish Department.

Rate of recreation use is climbing rapidly

Arizonians, like other Americans, are taking to the outdoors in ever-increasing numbers in pursuit of recreation. The desire to escape the summer heat of the desert cities is a compelling reason to seek out the higher, cooler forest. The Tonto National

A family enjoys a campground at Woods Canyon Lake on the Sitgreaves National Forest. This is one of more than 190 public campgrounds in the State. The manmade lake was constructed by the Arizona Game and Fish Department and provides boating, fishing, and swimming to recreationists. Campground facilities were constructed by the U.S. Forest Service.

Forest, which is the most accessible forest area to residents of Phoenix, received 2.4 million recreation visits in 1963 and ranked twentieth among the 154 National Forests in the country in volume of recreation use.

Since World War II, the number of recreation visits to Arizona's National Forests has climbed at a rate about double that of the Mountain States average.[11] Such visits in 1963 were nearly 16 times the figure for 1946. Several other Mountain States had more recreation visits than Arizona in 1963, but none had experienced as great an increase when compared with 1946. Recreation visits to Arizona's National Forests accounted for less than 8 percent of all such visits in the Mountain States in 1946; by 1960 Arizona's share reached 15 percent.

The following tabulation shows the number of recreation visits to National Forests in 1946 and 1963 for each of the Rocky Mountain States:

State	1946	1963
Arizona	**477,000**	**7,457,000**
Colorado	**1,449,000**	**12,460,000**
Idaho	**719,000**	**4,561,000**
Montana	**547,000**	**6,654,000**
Nevada	**102,000**	**817,000**
New Mexico	**336,000**	**4,940,000**
Utah	**2,261,000**	**8,882,000**
Wyoming	**402,000**	**4,006,000**
Total	**6,293,000**	**49,777,000**

Arizona's swelling population accounts for part of this rise. Other factors include the increasing mobility, affluence, and free time of the public. In 1960 the census of

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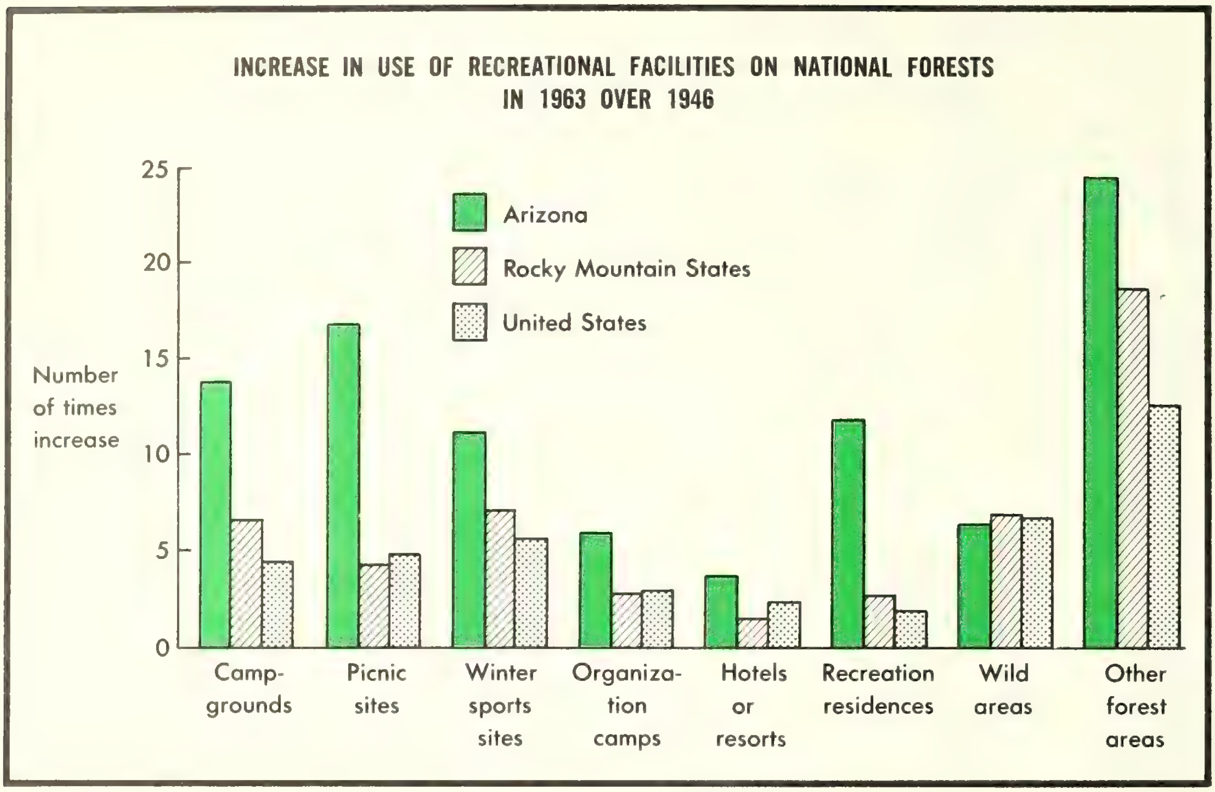
[11] *National Forest statistics on number of recreation visits are used here and elsewhere in this report for two reasons: (1) they are practically the only data available for forest land as distinguished from all lands that are used for outdoor recreation, and (2) they permit ready comparisons among States.*



the State showed 1,302,161 residents — an increase of 74 percent over the 1950 figure of 749,587 persons. This compares with a national population increase of 19 percent during the same period.

All forms of forest recreation have increased since 1946, some much more than others. As indicated by the chart below, picnicking and camping have become especially popular in Arizona in recent years. The numbers of visits to Arizona's National Forests in 1946 and 1963 by class of use were as follows:

	1946	1963
Campgrounds	75,470	1,032,800
Picnic sites	140,575	2,372,100
Winter sports sites	12,292	135,200
Organization camps	10,320	58,800
Hotels or resorts	88,801	328,100
Recreation residences	5,257	61,500
Wilderness areas	2,353	14,500
Other forest areas	141,523	3,454,000
Total	476,591	7,457,000

Recreation use of forest lands other than the National Forests has also increased sharply in recent years. The National Park Service, Fish and Wildlife Service, Navajo Tribal Parks Commission, and Arizona State Park Board all have active programs for forest recreation.

Hunting and fishing use of the forest, on the upswing in every State, is high in Arizona. Roughly one out of five Arizona residents 12 years or older participated in the sport during 1960 (Davis 1962). Fishermen paid over one million visits to waters in the National Forests in 1963. This represents an increase of 21 times the 1946 use, which was far above the Mountain States average rate of increase (7 times). The 316,000 visits by hunters in 1963 represent a tenfold gain over the number in 1946 compared with a Mountain States average increase of eight times during this period. An estimated 27,000 deer, elk, antelope, javelinas, and wild turkeys were harvested from Arizona's National Forests in 1963.

The amount of spending generated by hunting, fishing, and other forest recreation is an important addition to the economy of the State (Davis 1962). For example, estimates for 1960 indicate that big game hunters spent a total of more than $8.3 million during the year for lodging, additional food, special clothing, sporting equipment, and transportation. Cold water (trout) fishing—a large share of which is done in the streams and lakes within the forest—contributed another $12.2 million for the above items. Spending by out-of-State residents amounted to nearly 5 percent of the big game hunting expenditures and almost 9 percent of the trout fishing expenditures.

Arizona's rate of timber harvest is highest of the Mountain States

Timber harvesting in Arizona's forests has a history of long and fairly heavy use. As demand for Arizona wood increased, particularly since World War II, early selective logging practices gave way to intensified management that is among the best in the Mountain States. A concurrent development is that Arizona's cutting rate has become the highest of the Mountain States.

In 1962, 65.9 million cubic feet was harvested from an inventory of 6,091 million cubic feet of sound, live trees in Arizona. A comparison of 1962 cutting rates for each of the Mountain States follows:

State	*Percent of inventory cut*
Arizona	1.08
Idaho	1.02
Montana	.83
New Mexico	.60
Nevada	.36
Wyoming	.29
Colorado	.22
Utah	.22
Average	.69

Arizona's saw log cutting rate was even higher — 1.5 percent (404.9 million board feet from a sawtimber inventory of 26,951 million board feet). This was also more than 50 percent greater than the average for the Rocky Mountain States.

The first lumber produced in the territory of Arizona was pitsawed in 1856 in the Santa Rita Mountains south of Tucson. The location of the first sawmill in Arizona is not definitely known, but according to rec-

Edward E. Ayer's sawmill and crew in 1882 in Flagstaff. The town of Flagstaff developed because of the mill, which was engaged in supplying the Mexican Central and Atlantic and Pacific Railroad companies with ties and bridge timbers. Sawn railroad ties, which could be produced in much greater quantities than the previously used handhewn ties, permitted the rapid westward extension of the railroad. Today, timber and other forest uses are mainstays in Flagstaff's economy. (Photo courtesy of Arizona Pioneers' Historical Society.)

ords of the Arizona Pioneers' Historical Society, A. O. Noyes and George Lount built a steampowered sawmill near Prescott on Granite Creek in 1864.

Construction of the transcontinental railroads gave impetus to the sawmill industry. Several mills sprang up to produce bridge timbers and the millions of railroad ties needed to span the State. In addition, rail transport opened new markets for lumber. By 1899, there were 13 sawmills in Arizona having a combined production of 36.2 million board feet of lumber (Steer 1948). During those early years of development, a large volume of timber also was used for house logs, fuelwood, posts, poles, mine props, and other roundwood products.

In the early 1900's the larger lumber companies constructed their own railroad facilities to transport saw logs from the woods to the mill. In order to amortize their large investments in track-laying and equipment, these lumber companies found it necessary to harvest large volumes per acre. These logging activities covered a wide area, as presently evidenced by the large stumps scattered over much of the forested area in northern Arizona. With the advent of truck hauling of logs in the 1930's, it became economically feasible to harvest smaller volumes per acre.

Lumber production is still the principal timber industry

The number of sawmills in Arizona has declined from a peak in 1946 but lumber output for the State has increased. This has obviously caused average production per mill

Reidhead Lumber Company sawmill in Show Low. This mill produces 6 to 7 million board feet of lumber annually from logs harvested on National Forest and Indian lands. Logs are debarked before being sawed, and slabs, edgings, and trim ends are chipped and hauled by a contractor to a pulpmill 35 miles away. A market for these residues is a substantial benefit to sawmills.

to rise as shown by the following tabulation for selected years:

Year	Number of Sawmills	Lumber production Total	Per mill
		Million board feet[1]	
1946	**66**	**240.7**	**3.6**
1954	**31**	**258.2**	**8.3**
1960	**38**	**329.9**	**8.7**
1962	**28**	**326.0**	**11.6**

[1] *Lumber tally*

Arizona's average production per mill during 1962 was higher than the average for the Mountain States, which was 4.3 million board feet.

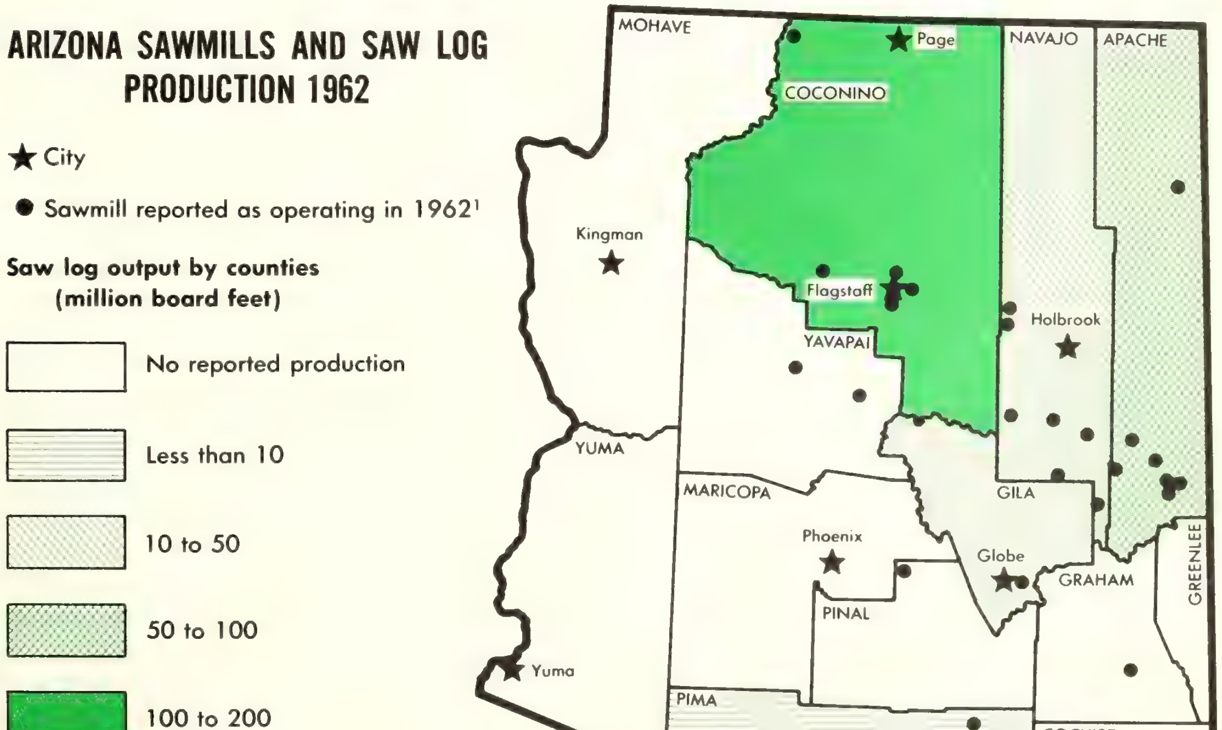
This trend toward fewer but larger and more efficient mills has occurred throughout the Mountain States. In 1962 most of Arizona's sawmills produced more than 1 million board feet of lumber as shown below:

Sawmill size class[1] *Thousand board feet per year*	Number of sawmills
Less than 50	**0**
50 to 199	**5**
200 to 499	**3**
500 to 999	**0**
1,000 to 4,999	**7**
5,000 and over	**13**
Total	**28**

[1] *Saw log receipts rather than lumber production were used as the basis for classifying sawmills because lumber production statistics were not available in sufficient detail.*

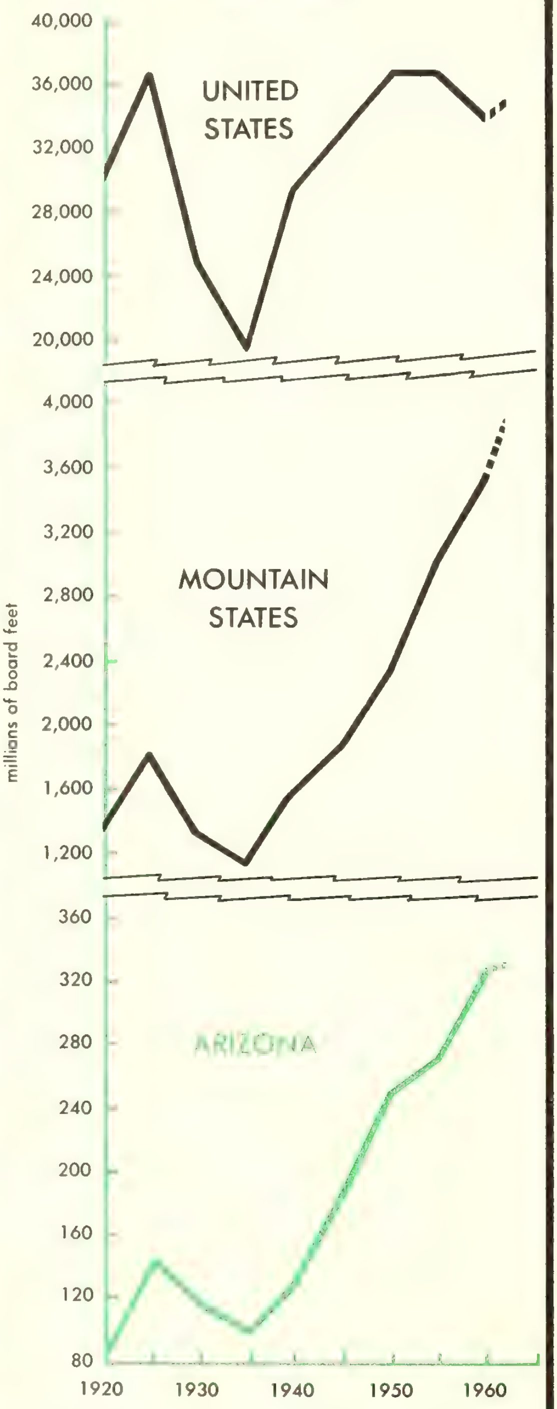
The map below shows the distribution of active sawmills as well as the principal saw log producing counties in 1962. Coconino

ARIZONA SAWMILLS AND SAW LOG PRODUCTION 1962



[1] *In addition to the 26 mills shown, there were an estimated two active sawmills in Arizona, both small, for which saw log receipts were not received in the 1962 products survey.*

LUMBER PRODUCTION TRENDS, 1920—1962[1]



[1] *Plotted on the basis of 5-year averages — e.g. averages for years 1923 - 1927 plotted on 1925.*

County was the only county in which more than 100 million board feet of saw logs was harvested.

The trend of lumber output in Arizona has closely paralleled that of the Mountain States as illustrated by the graph on this page which also provides a comparison with the lumber output of the United States since 1920.

In recent years, saw logs have comprised the bulk of the harvest of timber products. In 1962, they made up 76 percent of all products. Round pulpwood production — practically nonexistent before 1961 — ranked next to saw logs in volume harvested in 1962, constituting 12 percent of the harvest. The output of other roundwood products — commercial poles, round mine timbers, posts, fuelwood, and miscellaneous farm and industrial timbers — has declined sharply. Even with the addition of pulpwood, the 1962 yield of other roundwood amounted to only 58 percent of the 1952 harvest. The diminishing market for small roundwood products is a handicap to good timber management. However, the downward trend may be slowed, or even reversed, to the extent that the market for round pulpwood increases to meet the needs of the State's two pulpmills — one of which will rely solely on roundwood. In addition to the volume presently needed to supply these mills, an estimated annual cut of 75,000 to 85,000 cords of round pulpwood is feasible for at least the next 20 years.

A breakdown of the 1962 timber products output follows:

	Cubic feet
Saw logs (for lumber)	**49,555,000**
Pulpwood (round)	**7,947,000**
Poles	**125,000**
Mine timbers (round)	**556,000**
Converter poles, excelsior bolts, charcoal wood, and house logs	**389,000**
Posts, fuelwood, miscellaneous farm timbers	**6,957,000**
Total	**65,529,000**

Pulpwood production in Arizona began in earnest with completion of the Southwest Forest Industries, Inc., pulpmill near Snowflake in 1961. This mill, shown above, uses round pulpwood and chipped sawmill residues (foreground) to produce about 140,000 tons of kraft linerboard and newsprint per year. Another pulpmill in Flagstaff plans to use round pulpwood exclusively.

Value of timber products higher than average for Rocky Mountain States

The economic value generated from Arizona's timber resource is high compared to that of other Mountain States. Even before the advent of a pulp and paper industry in 1961, the State's timber industries ranked high in value produced. For 1958,[12] it was estimated that the average value of roundwood timber products cut in the State was $80.60 per thousand cubic feet (U. S. Forest Serv. 1963). This ranked highest in the Mountain States, the average for which was $48.84 per thousand cubic feet, but below the average for the United States, which was $99.37 per thousand cubic feet.

Value added by manufacture is another useful yardstick in evaluating the economic impact of the timber resource. Such data show the amount of money added to the economy by the harvesting and processing of the resource. Such information is available for all timber industries in the Mountain States, except the pulp and paper industry, for 1963.[13] Even without the latter, Arizona's timber harvest generated more than $24 million into the State's economy. This amounts to a value added of about $368,000 for each million cubic feet cut of sound, live trees. In this respect, Arizona ranks above the average for the Mountain States, which is about $340,000.

Capital expenditures on plant and equipment — an expression of industry's confidence in the future — is still another basis for comparison. Such long-term investments by Arizona's timber industries, except the pulp and paper industry, increased from about $1½ million in 1958 to over $2½ million in 1963. The latter figure represents investments of about $428,000 for each billion cubic feet of growing stock inventory in the State. This is more than 1.4 times the average for the Mountain States, which is about $300,000.

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[12] *1958 is the latest year for which there is Census of Manufactures data of the type used for this analysis.*

[13] *U.S. Bureau of the Census provides an estimate of value added by manufacture for Standard Industrial Classification Code 24. This classification includes logging operations, sawmills, planing mills, millwork plants, wood preserving concerns, and similar wood conversion industries. An estimate of value added by manufacture of pulp and paper (SIC Code 26) has not been published by the Bureau of the Census for any of the Mountain States.*

If similar comparisons could be made using data that includes the pulp and paper industry, Arizona probably would appear in an even more favorable position. Paper industry products are of relatively high value and are manufactured from wood in only two of the Mountain States other than Arizona. The two operating pulpmills in Arizona provide many benefits to the State in the form of profits, wages, and taxes. The market they provide for saw log residues and small roundwood (see photo page 33) benefits sawmills and management of many timberlands.

The lumber industry has inherent problems

Despite the cheerful economic picture presented by these analyses, the lumber industry is faced with serious problems. Primary among these is the fact that the major wood product manufactured in Arizona, in terms of volume of wood, is still 1-inch-thick lumber. This provides cause for concern in view of the increasing encroachment by plywood and other sheet product manufacturers into the market for sheathing and subflooring materials — a high volume market formerly dominated by the lumber industry. This concern is accentuated because no plywood or veneer presently is produced in Arizona. Another problem is the high proportion of low-grade lumber produced from Arizona sawtimber. Lumber grade recovery from Southwest ponderosa pine commonly includes as much as 40 percent grades 4 and 5 common lumber (Barger and Fleischer 1964). These poor grades have always been marginal profit items, especially so in a sluggish market. They command low prices and are difficult to market. Therefore, their value added by manufacture is small.

The secondary manufacture of wood products is a small factor in Arizona's forest industries. There were only 28 millwork plants in Arizona in 1958 (U. S. Bureau of the Census 1961), most of which were small. The potential exists for expansion of millwork operations because a large volume of lumber is shipped out of the State to be remanufactured. A stronger industry producing such items as moulding, trim, window sash, and doors would be desirable for the economy of the State.

A combination of the above factors and a generally depressed national lumber market during the mild recession of 1960-61 caused lumber production and prices in Arizona to sag in the early 1960's. Recovery has been slow, but some indicators point to a small recent improvement in market conditions. The lumber output, which declined from 340 million board feet in 1959 to 326 million board feet in 1962, spurted to a new high of 411 million board feet in 1964.[14] Stumpage prices bid for ponderosa pine sawtimber sold on National Forests in the Southwest also suggest the economic climate may be improving somewhat for the lumber industry. Stumpage prices, which averaged $10.49 per thousand board feet in 1960 and slumped to $4.78 in 1962, rose slightly to $5.79 in 1964.

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[14] *U. S. Bureau of the Census preliminary figure, subject to change.*

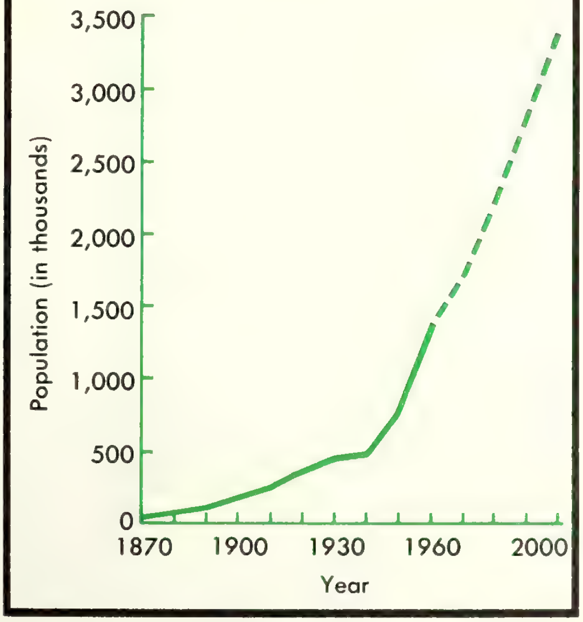
Harvesting mature ponderosa pine on the Coconino National Forest. Sawtimber trees in the Southwest usually produce a high proportion of low-grade saw logs, largely because of the presence of many large, live limbs. Eighty-five percent of the total ponderosa pine sawtimber volume is from grade 4 saw logs — poorest in the log grading system used. (See Terminology in the Appendix for definitions of log grades.)

THE FUTURE

Demands on the forest will grow

Future demands on Arizona's forest resources will intensify and become increasingly competitive. Projections of demands on forest resources are unanimous in estimating that future use will be much heavier than it is presently. The projected rate of increase of use, however, differs markedly for each resource. Demand for water, for instance, is expected to mount sharply between now and the year 2000 in contrast to the slower growing demand for timber. There will also be big differences in the extent to which these demands on the forest can be met. In general, opportunities appear greatest for expanding recreation and timber uses in the next few decades. A much more vigorous program of range improvement work will be necessary before there can be any substantial increase in range use. And considerably more research is needed in both watershed and multiple use management before water yields can be materially increased.

POPULATION OF ARIZONA FROM 1870 TO 1960, AND PROJECTED POPULATION TO 2000



Sources: U.S. Bureau of the Census and Select Committee on National Water Resources, U.S. Senate, 86th Congress.

Projections of any kind require assumptions, and an important assumption basic to this discussion is the growth of the country's population. The latest median projection by the Bureau of the Census indicates the 1965 United States population of 195 million persons will swell to about 325 million in 2000. In Arizona, a conservative projection to 2000 indicates a number about 2½ times the 1960 census (U. S. Senate 1960). The graph on this page shows population of the State from 1870 to 1960 and a projection to 2000.

Assumptions, such as projected disposable personal income, use of competing resources or materials, technological changes, consumer preference, and others, cause the projected rates of use to differ among individual resources.

As discussed earlier, water is critical to the growth of Arizona because water needs in the future are going to be much greater than at present. Approximately 3.5 million acre-feet of additional surface water will be needed by 1980 (U. S. Senate 1960).

Most of the needed supply of surface water probably will come ultimately from diversion of water to the State from areas of water surplus. But this will require an interstate geopolitical approach to water problems — a situation which may not come to pass for a considerable time. Therefore, the role of the forest in helping to supply a small part of the water deficit is important.

There is some opportunity to increase the availability of water by vegetative manipulation, but the amount of increase that can be achieved and the best methods to achieve it remain to be learned. If research points the way to watershed management practices that will increase water yield from the forest even slightly, the immediate returns will be significant in relaxing the stringency of this resource. However, it is probable that any significant amounts of additional water yield resulting from vegetative manipulation will compete in some degree with timber outputs and, perhaps, with recreation benefits because these practices are likely to be most effective in increasing water yields in the commercial forest. If such practices are adopted widely over the State, important questions will be raised regarding new timber management objectives and the best management programs to accomplish them.

The present use of the forest for recreation pales beside what may be expected in future years. Projections for the period 1960 to 2000 indicate that the Nation's population will nearly double and participation in outdoor recreation will nearly triple (Outdoor Recreation Resources Review Commission 1962).

The increased pressures on public recreation lands during this period are expected to vary as shown in the following projections made by Resources for the Future, Inc. (Landsberg et al. 1963):

	1960	2000
	Million	*visits*
National Parks, Monuments, and Recreation Areas	**41**	**390**
National Forests	**93**	**2,010**
State Parks	**259**	**2,770**

Based upon these projections, the greatest impact will be felt on National Forests because the number of projected visits for 2000 amounts to 21.6 times the number of such visits made in 1960. At the same time, the number of visits to State Parks is expected to increase about 10.7 times and to areas administered by the National Park Service 9.5 times.

Future demand for forage for livestock and wildlife undoubtedly will remain heavy. Principal opportunities for increasing the forage supply in the forest involve more intensive management of existing grazing lands, rehabilitation of depleted ranges, conversion of pinyon-juniper forests to grasslands, and thinning overstocked young stands of pine.

Demand for timber is expected to rise, too. Use of timber products nationally is projected to increase about 81 percent by 2000 (U. S. Forest Serv. 1965). The estimated demand by the end of the century for pulpwood, plywood, and veneer is 2.7 times the 1962 level of consumption. These are the products for which future demand is expected to increase most sharply. Lumber demand is expected to rise only 43 percent during the same period.

The harvest of sound, live trees in the Mountain States in 1962 is expected to double by 1992. A projection of Arizona's estimated cut suggests an increase of only 78 percent during the same period. The reason for Arizona's lower projection is twofold: (1) Its current cutting rate is already the highest of the Mountain States; and (2) the present harvest already is close to established allowable annual cutting rates. Arizona's projected cut in 1992 — 118 million cubic feet — is only 69 percent of the potential yield mentioned earlier. In 1962, only 38 percent of this potential yield was harvested — 66 million cubic feet.

However, future harvest rates depend to some extent on the action program that evolves from the current study of means of increasing water production from the forests of the State. If drastic cutting measures are deemed advisable, it is conceivable that many watersheds will be harvested on a greatly accelerated schedule during the next few decades.

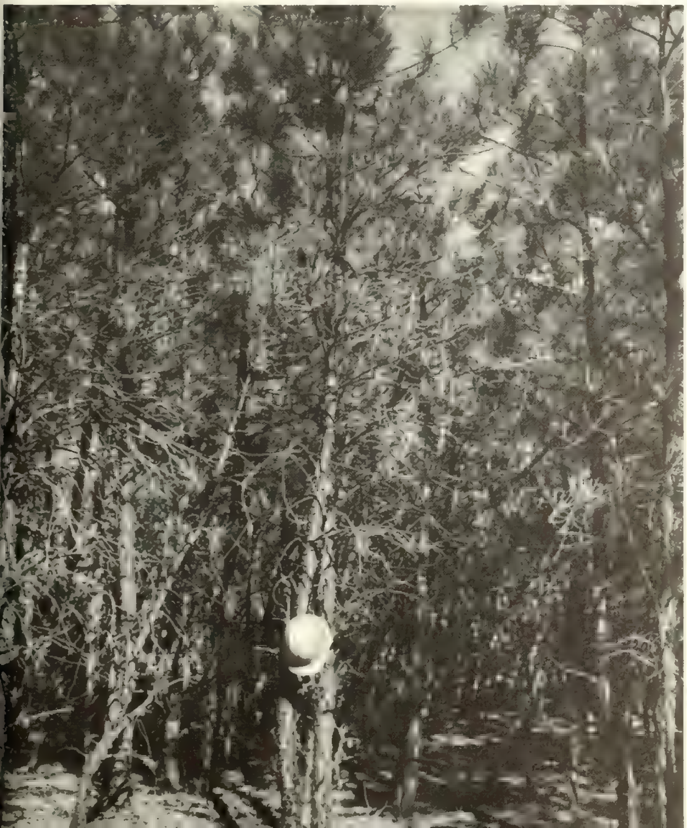
The future increased harvest must come in the face of a shrinking area of commercial forest land as more of these lands are used for highways, roads, powerlines, reservoirs, or urban and industrial development. The accelerated harvest also will be accomplished despite the continuing need for careful management of all uses to prevent deterioration of fragile soils. Some areas may be deferred from logging rather than risk damage to soils, which take a long time to restore in this dry country. Most of the increased timber demands must be met by closer utilization in the woods and mill and by more intensive timber management.

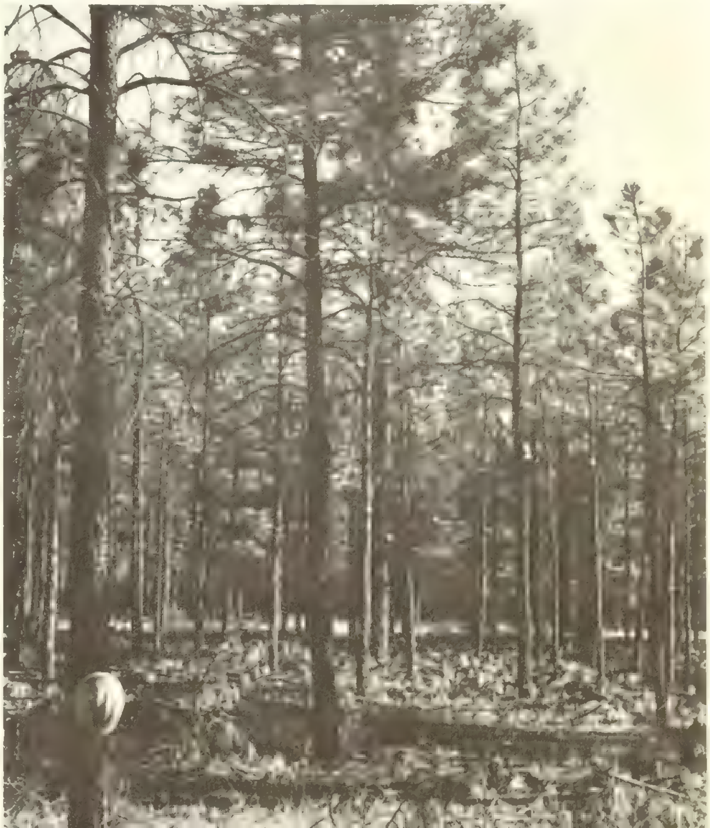
Arizona enjoys a fairly favorable location with respect to markets for her forest products. The rapid population growth of the West in general and the Southwest in particular has meant expanded market opportunities. The future looks equally bright. Population in 2000 in the Mountain and Pacific Coast States is expected to be 2.2 times that of 1960, compared with an increase of 1.8 times the 1960 population for the country as a whole (U. S. Senate 1960). This westward migration suggests an improving market situation. Markets for lumber have been largely in States that lie east of Arizona. In the future, a larger share of these markets probably will be in the Mountain and Pacific Coast States. Proximity to mushrooming southern California makes this a particularly inviting market area.

Thinning is needed to accelerate growth

There are big opportunities for increasing yields from Arizona's timberlands in the future. In most western States, the harvest of large areas of virgin timber is a necessary first step before real timber management can begin. As mentioned previously, Arizona is not handicapped by large areas of old, decadent timber that should be harvested and replaced by vigorous young growth. However, Arizona does have large areas of cutover and young-growth timberlands that are growing at rates far less than their potential. Some of these lands are overstocked

The photo on the left illustrates an all too common problem in Arizona — the overcrowding of young ponderosa pines in wild stands. These saplings on the Fort Apache Indian Reservation average 2 to 3 inches d.b.h., 10 to 12 feet in height, and are 40 to 50 years old. Growth has stagnated and quality and form of the trees are poor. Precommercial thinning is costly but necessary if stands like this are to be brought into useful production. The stand shown in the photo on the right is several hundred yards from the unthinned stand described above. This sapling-pole stand was thinned to a spacing of about 12 by 12 feet.





and need to be thinned. However, surveys are needed to locate stands in which thinning would be most profitable. Work also is needed over a wide area to remove trees of poor species, form, or vigor, or that are overtopping more desirable young growth. In spite of the large amount of stand improvement work accomplished over the years, much remains to be done. In 1964, over 18,000 acres were treated in this manner on National Forests in the State, but there are many areas still in need of such treatments.

Tree diameter growth usually shows good response to thinning where this work has been done properly. Some of the early thinning done in Arizona removed too few trees per acre to cause anything but a short-lived increase in growth. It probably will be necessary to thin stands much more heavily than is presently being done to accelerate growth of small trees sufficiently to insure a continuous high flow of saw logs. Studies underway by the Rocky Mountain Forest and Range Experiment Station are designed to provide better thinning guidelines.

The system of harvesting ponderosa pine in the Southwest is in the process of shifting from all-aged to even-aged management. In the past, the largest and oldest trees usually were selected for cutting. This practice left a residual stand composed of trees of many age classes. Recently the seed-tree method has gained wide acceptance. A few prolific seed-producing trees per acre are left to regenerate the area after logging. If natural regeneration has not become established within several years, the area is artificially regenerated. Artificial regeneration, in most cases, requires site preparation, an important part of which is the removal of competing vegetation from the area to be planted. These practices are expensive — combined costs may average $80 to $100 per acre. For some areas another system of cutting, such as the shelter-wood method, may prove most satisfactory. When this method is used, mature timber is removed in a series of cuttings, which extend over a period of years. Natural regeneration is encouraged under the partial shelter of seed trees left standing.

Artificial regeneration will increase

Not much artificial regeneration had been done in Arizona until recently, and the total number of acres planted or seeded to date is small compared with similar figures for other western States. Almost all of the 6,489 acres that have been planted or seeded to forest trees in the State have been within the National Forests. During 1964, only 521 acres were planted and 235 acres were seeded, and these were all on National Forest lands.

There is an estimated 65,000 acres of nonstocked commercial forest land in the State. In addition, there are 627,000 acres of poorly stocked commercial forest land, a sizable portion of which requires regeneration. More exact figures on areas needing regeneration will be known when the more detailed ground surveys currently underway on National Forests are completed. Also, as more areas are logged, they will have to be planted or seeded as necessary to assure adequate stocking. Obstacles to reforestation in the Southwest are formidable — drought, excessive vegetative competition, and damage to seedlings by rodents, insects, large vertebrate animals, and other agents. However, most foresters in Arizona are confident that artificial regeneration can be successful. Direct seeding costs much less than planting seedlings, and probably will be used much more in the future.

How to utilize low-quality sawtimber is a major problem

Arizona's forests have large volumes of ponderosa pine sawtimber that have too many knots for manufacture into good quality lumber. This poor quality is largely the result of the failure of ponderosa pine to prune well naturally. The quality of sawtimber is expected to decline further as the remaining old-growth stands are liquidated.

These stands yield the higher grade saw logs. Pruning, of course, will improve tree quality, but at present it is not considered economically justified for most stands. Not much pruning has been done in the past. Only 344 acres were pruned on the National Forests in Arizona during 1964. If pruning remains at about the same level, it is unlikely that future timber quality will improve substantially.

Perhaps the biggest problem facing the forest products industry in the State is how to utilize low-grade sawtimber profitably. As mentioned earlier, much of this material is of poor quality for the production of lumber. It seems likely that the future course of industry will move toward the fabrication of wood substitutes for lumber. Barger and Fleischer (1964) have demonstrated the technical feasibility of manufacturing several of these products utilizing low-grade ponderosa pine sawtimber. Among these products are glue-laminated beams, underlayment plywood, overlaid siding, flooring made with a lumber core and a veneer surface, and particle board.

A diversification of at least part of the industry along these or similar lines would mean a further healthy departure from the single-product operations of the past. As mentioned previously, there are no veneer or plywood plants in the State at present. Few "peeler" logs are produced in the forests of the Southwest from which conventional high-grade plywood can be manufactured. However, recent veneer volume and grade recovery tests have indicated that Southwest ponderosa pine will yield commercially acceptable sheathing grade plywood (Barger 1965).

Accelerated road construction is essential

A good network of roads is necessary not only to manage timber but to permit access for fire protection, recreation, and other uses of the forest. While many stands have been made accessible for timber harvesting, a large number of the roads constructed in the past are substandard — particularly from the standpoint of multiple use needs. Reconstruction of these roads and new construction of others must go ahead rapidly on public lands if projected demands on the forest are to be met. The National Forest road development program for fiscal years 1963 to 1972 calls for the following new road construction and reconstruction:

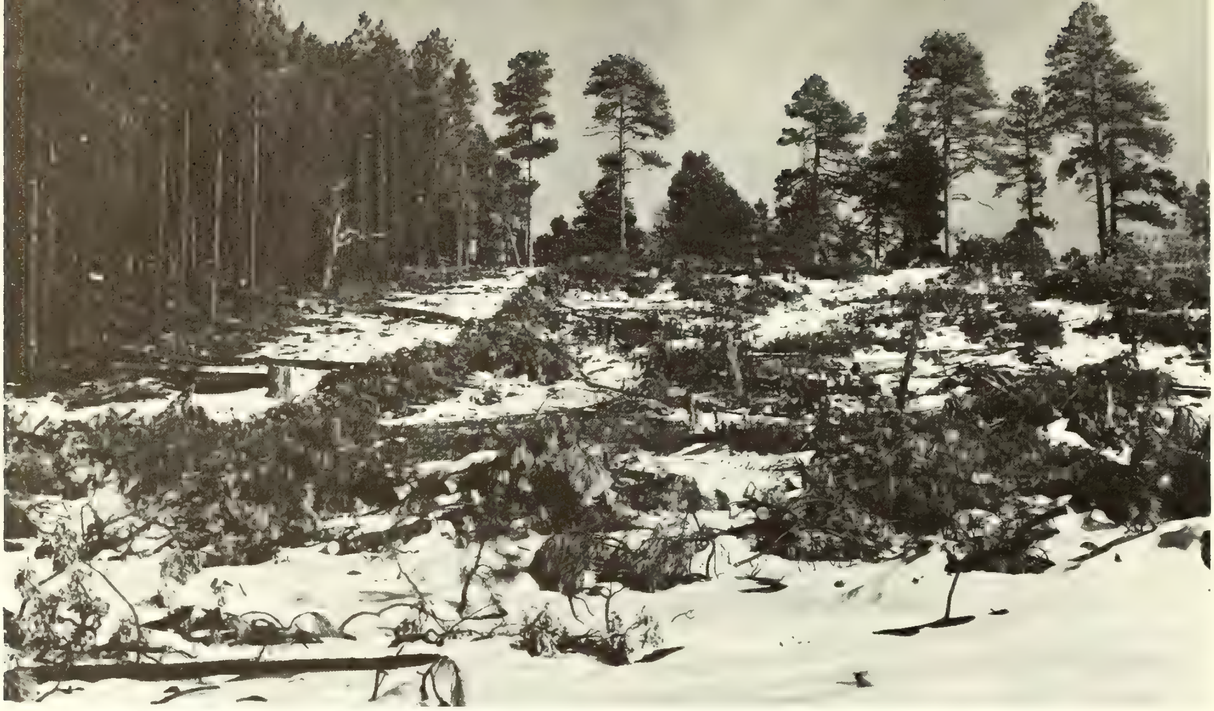
	Miles
Timber roads	**869**
Recreation roads	**496**
Other roads	**1,184**
Total	**2,549**

This means that an average of over 250 miles of roads per year need to be built or rebuilt on the National Forests to meet the program goal. Funds in fiscal years 1963 and 1964 permitted completion of 122 and 137 miles, respectively.

The necessity for building many multipurpose roads will ultimately benefit timber management, especially in financing of road construction. At present, some remote stands cannot be logged profitably if the full cost of access roads must be borne by the timber operation; volumes per acre and timber quality are low and logging costs are high in relation to current market prices for timber. However, when road construction is financed on the basis of benefit to all uses served, a greater area will become economically feasible to log. In the future a great proportion of road financing on public lands will undoubtedly be by direct appropriations rather than solely by timber sale monies.

Technical and fire protection assistance now available from State Forester

The establishment of a state forestry organization in early 1966 — Arizona was the last State to appoint a State Forester — marked the beginning of better management for State and privately owned forest lands. Owners of private forest land now can obtain technical assistance on tree planting and the management of their lands. The State will



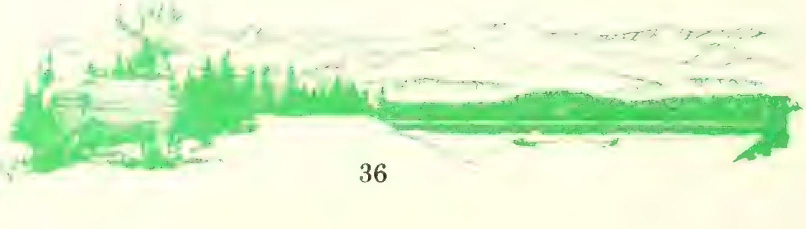
Experimental stripcutting of ponderosa pine in the Beaver Creek watershed, Coconino National Forest. Experiments using other vegetative manipulation treatments are also being conducted in this watershed — aimed at providing economic evaluations of the forest resources. Changes in water yields are weighed against the effects of these treatments on erosion abatement, timber and forage production, wildlife habitat, and recreation uses.

also begin a cooperative forest fire control program. A recent study requested by the Governor of Arizona prior to his appointment of a State Forester indicated a need for fire protection on about 2¾ million acres of noncommercial forest land in State and private ownership in Arizona. This cooperative program will insure adequate protection of these lands.

Research will help to smooth the way into the future

There is a long history of forest research in Arizona. The Fort Valley Experimental Forest located on the Coconino National Forest, was established in 1908 — the first forest experiment station in the United States. Information learned there over the years has done much to improve the methods of managing ponderosa pine in the Southwest. Investigations into other related fields were necessary as multiple use demands became stronger. Today research projects by several agencies are underway elsewhere in Arizona in timber management, range management, forest protection, watershed management, wood utilization, wildlife habitat, and multiple use management.

Multiple use management will be required if the mounting demands are to be met. The challenge of the future will be to do more on a fixed land base — 21 million acres of forest area, including 4 million acres of commercial forest. Conflicts among users will inevitably arise as more people, with a wide variety of needs, make use of the forest. Pressure on forest land managers from single-interest groups can be expected to increase in the future. Research will help to show the way toward minimizing these conflicts and in using the forest most efficiently.



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APPENDIX

TERMINOLOGY

Forest Land

The term *forest land* includes (a) land which is at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10 percent stocking; and which has not been developed for other use; (c) afforested areas.

At the time the fieldwork for this report was performed, the minimum unit of area for forest land classification was 10 acres with a minimum width of stringer strips of 120 feet.

The principal classes of forest land are:

Commercial forest land. — Forest land which is (a) producing, or is physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; (c) not withdrawn from timber utilization.

Noncommercial forest land. — Three classes of noncommercial forest land are recognized: *Productive-reserved*, *Unproductive-nonreserved*, and *Unproductive-reserved.*

Productive-reserved is public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

Unproductive indicates forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions or forest land so physically inaccessible as to be unavailable economically in the forseeable future.

Forest Types

Forest land is classified into types on the basis of tree species; the type name is that of the predominant species. The predominant species is the one which has a plurality of (a) gross cubic volume in sawtimber and poletimber stands, or (b) the number of stems in seedling and sapling stands. Both growing stock and cull trees are considered in the classification. Forest types which occur on both commercial and noncommercial forest land are:

Douglas-fir	Fir-spruce
Ponderosa pine	Aspen

Additional forest types which occur only on noncommercial forest land are:

Pinyon-juniper

Chaparral

Other (unclassified)

Tree-Size Classes

Sawtimber-size tree

A tree 9.0 inches d.b.h. or larger for softwoods and 11.0 inches d.b.h. or larger for hardwoods.

Pole-size tree

A tree 5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods.

Sapling-seedling trees

Trees at least 1-foot high and less than 5.0 inches d.b.h.

Tree-Merchantability Classes

Sawtimber tree

Live tree of commercial species, 9.0 inches d.b.h. or larger for softwoods and 11.0 inches d.b.h. or larger for hardwoods, that contains at least one 12-foot log to a merchantable top diameter and having the likelihood of eventually containing at least a 16-foot minimum saw log. Also, at least one-third of the board-foot volume must be free from rot or other defect.

Poletimber tree

Live tree of commercial species, 5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods, free of rot and having the likelihood of growing into a sawtimber tree.

Sapling and seedling trees

Live trees of commercial species, less than 5.0 inches d.b.h., with form and quality to qualify as potential poletimber trees.

Growing stock trees

Sawtimber trees, poletimber trees, saplings and seedlings; i.e., all live trees except cull trees.

In discussion and tables on volumes, growth, and mortality, the term *growing stock* refers only to sawtimber trees and poletimber trees; i.e., all live trees 5.0 inches d.b.h. and larger (except cull trees). Saplings and seedlings are not part of growing stock in this usage of the term.

Cull tree

Live tree of sawtimber or poletimber size that is unmerchantable for saw logs, now or prospectively, because of rot or other defect, or species.

Sound cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull with at least one-half of this cull the result of sweep, crook, or other sound defect. Also included are sound trees which do not contain at least one 12-foot saw log.

b. Poletimber-size trees that are unlikely to grow into sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, crooks, or girdling by porcupine. No rot may be present.

Rotten cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull, with more than half of the cull due to rot.

b. Poletimber-size trees showing any evidence of rot in the main stem.

Mortality tree

A tree 5.0 inches d.b.h. or larger, standing or down, which has died within the past 5 years and was not a cull tree at time of death.

Salvable dead tree

Dead tree 5.0 inches d.b.h. or larger, standing or down (but not lying on the ground) which has 50 percent or more of its cubic-foot volume in sound wood.

Stand-Size Classes

Sawtimber stands

A stand at least 10 percent stocked, with half or more of this crown density stocking in sawtimber and poletimber trees and with sawtimber stocking at least equal to poletimber stocking.

> *Old-growth sawtimber.*—A sawtimber stand in which 50 percent or more of the net board-foot volume is in trees of rotation age and older.
>
> *Young-growth sawtimber.* — A sawtimber stand in which 50 percent or more of the net board-foot volume is in trees under rotation age.

Poletimber stand

A stand at least 10 percent stocked, with half or more of this crown density stocking in sawtimber and/or poletimber trees and with poletimber stocking exceeding that of sawtimber stocking.

Sapling and seedling stand

A stand at least 10 percent stocked, with more than half of this crown density stocking in saplings and/or seedlings.

Nonstocked area

An area not qualifying as a sawtimber, poletimber, or a sapling-seedling stand;

i.e., normally an area less than 10 percent stocked.

Stocking

Stocking is a measure of the degree to which growing space is utilized by live trees. In this report it is expressed as the percentage of the available space that is occupied by tree crowns as viewed on aerial photographs.

Well-stocked stand

A stand that is 70 percent or more covered by tree crowns.

Medium-stocked stand

A stand with 40 to 70 percent coverage by tree crowns.

Poorly stocked stand

A stand with 10 to 40 percent coverage by tree crowns.

Nonstocked area

An area with less than 10 percent coverage by tree crowns.

Timber Volume

All-timber volume

Volume in cubic feet of sound wood in the bole of growing stock, cull, and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top inside bark.

Growing stock volume

Net volume in cubic feet of sawtimber trees and poletimber trees from stump to a minimum 4.0-inch top inside bark.

Live sawtimber volume

Net volume in board feet, International ¼-inch rule, of the saw log portion of sawtimber trees.

Saw log portion

That portion of the bole of sawtimber trees between the stump and the merchantable top.

Merchantable top

The point at which the upper limit of saw log merchantability is limited either by limbs or by a minimum diameter. The latter ranges from 5 to 10 inches inside bark depending on d.b.h. and species.

Upper-stem portion

That part of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches inside bark.

Quality class

A classification of sawtimber volume in terms of log grades. Four grades are recognized and distinguished by the occurrence and characteristics of knots. The log grades corresponding to the quality classes are:

Grade 1 (select logs) are essentially smooth and surface clear, except that in logs 16 inches and larger in diameter a few visible knots are permitted, providing there are no more than 1 large knot, or 2 medium or small knots, or 4 pin knots. Knot sizes for all grades are:

Pin knots — 0.5 inch or less
Small knots — 0.5 to 0.75 inch
Medium knots — 0.75 to 1.5 inches
Large knots — over 1.5 inches

Those logs that have a greater number of knots are admitted provided these knots may be boxed in an area not exceeding one-third the area of one face or an equivalent area of two faces.

Grade 2 (shop logs) display relatively few knots of any size, so spaced that at least 50 percent of the surface of the log is in smooth, clear areas, the size of which must be at least one-fourth the girth of the log in width, by 4 feet or more in length.

A log with no more than 12 medium or smaller knots, or more than 8 large ones, may be immediately classed as grade 2. If this number of knots is exceeded, the clear area basis governs.

Grade 3 (common logs) display either (a) pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab, or (b) 16 dead knots (an average of 4 per face) averaging medium in size.

Grade 4 (low common logs) display medium, large, and very large live and/or dead knots in excess of the numbers permitted in grades 2 and 3.

Growth

Net annual growth of sawtimber or growing stock

The average annual change, calculated from the total change over a 10-year period, in net board-foot or cubic-foot volume of live sawtimber or growing stock on commercial forest land.

Mortality

Net annual mortality of sawtimber or growing stock

The average annual net board-foot or cubic-foot volume removed from live sawtimber or growing stock through death, calculated from the total net volume removed by such causes over a 10-year period.

Timber Cut

Timber cut from growing stock

The volume of sound wood in live sawtimber and poletimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Timber cut from sawtimber

The net board-foot volume of live sawtimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Logging residues from growing stock

The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging on commercial forest land and not converted to timber products.

Ownership Classes

National Forest lands

Federal lands which have been designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the Forest Service, including experimental areas.

Other Federal lands

Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies.

State lands

Lands owned by the State.

County and municipal lands

Lands owned by counties and municipalities.

Forest-industry lands

Lands owned by companies or individuals operating wood-using plants.

Farmer-owned lands

Lands owned by operators of farms or ranches.

Miscellaneous private lands

Privately owned lands other than forest-industry or farmer-owned lands.

Principal Tree Species

Softwoods	
Douglas-fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Fir, corkbark	*A. lasiocarpa var. arizonica*
Fir, white	*A. concolor*
Juniper	*Juniperus spp.*
Pine, limber	*Pinus flexilis*
Pine, ponderosa	*P. ponderosa*
Pinyon	*P. spp.*
Spruce, Engelmann	*Picea engelmannii*
Hardwoods	
Aspen, quaking	*Populus tremuloides*

SURVEY METHODS

Area statistics were determined by two methods:[15] (1) On National Forests, forest lands were mapped on aerial photographs according to forest type, stand size, and crown density. Photo delineations were transferred to base maps. Maps were then dot counted to obtain the estimates of area by the various land and forest classes. (2) For all lands not in National Forest ownership (except certain Indian Reservations), a sampling procedure was used. Points were classified on aerial photos to determine the proportion of area by forest versus nonforest, class of forest, and ownership. A percentage of the points was checked on the ground for correctness of classification. Results of the field check were then used to adjust photo estimates of proportions. Acreages were determined by applying the adjusted proportions to the total acreage of the sampled area.

Volume estimates are based on tree measurements taken on 3,207 sample areas located at random on commercial forest land. Sample locations were pricked on aerial photos, then located on the ground and established on a permanent basis to permit remeasurement on future surveys. Two different sampling procedures were used: (1) On National Forests measurements were taken on circular plots of fixed radius. Each plot consisted of four circular and concentric subplots. The area of subplots and size class of trees (live and dead) of commercial species tallied on each are as follows:

1/250-acre — seedlings
1/50-acre — saplings
1/10-acre — pole-size
1/4-acre — sawtimber-size

(2) On non-National Forest lands, sample locations were approximately 1 acre in size. Each location was subsampled at 10 points. At each point, trees were tallied on two plots — one of fixed radius (1/250-acre) and one of variable radius. On the former, all trees were measured and live noncull trees were classified as crop trees or excess trees from the standpoint of management treatment. The variable radius plot (trees are sampled in proportion to their basal area) was used for live sawtimber trees and for mortality sawtimber trees.

Under both of the systems described above the customary measurements and classifications of trees were made for volume and quality, and increment borings were taken for growth estimates.

Per-acre values of volume, growth, and mortality were obtained from the field samples. These averages, applied to area estimates, provided volumes shown in appendix tables.

Estimates of timber cut are based on periodic surveys of forest industries. The latest survey was in 1962 and is the basis for data shown in the appendix tables. Utilization trends discussed in the text are based mainly on lumber production data, since information on output of all products is available only for 1952, 1960, and 1962.

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[15] *Methods described here are those that were used for inventorying all forest lands except those within the Navajo, Ft. Apache, San Carlos, and Hualapai Indian Reservations. Data for these lands were provided by the Bureau of Indian Affairs from their management plan inventories.*

RELIABILITY OF ESTIMATES

Accuracy objectives for the timber inventory of Arizona were as follows:

	Allowable sampling error[1]
Commercial forest area	3 percent per million acres
Noncommercial forest area	10 percent per million acres
Growing stock volume on commercial forest land	10 percent per billion cubic feet
Net annual growth of growing stock on commercial forest land	15 percent per billion cubic feet

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[1] *In terms of one standard error.*

Sampling errors actually obtained for the State as a whole are not known. They have been computed for certain parts of the State from basic data provided by some of the several agencies that made inventories of their own lands. For certain large areas, however, the basic field and photo data necessary for computing errors were not available.

The following sampling errors have been computed for timber cut and timber products output in 1962:

	Volume	Sampling error[1] percent
Timber cut from growing stock	65,941 M cu. ft.	5.2
Timber cut from sawtimber	404,850 M bd. ft.	5.5
Timber products output	65,529 M cu. ft.	5.2

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[1] *In terms of one standard error.*

TIMBER STATISTICS

Table 1.—**Area by land classes, Arizona, 1962**

Land class	Thousand acres
Commercial forest land	3,977
Unproductive forest land	16,268
Productive-reserved forest land	353
Total forest land	20,598
Nonforest land	52,090
All land	[1]72,688

[1] *From U.S. Bureau of the Census, Land and Water Areas of the United States, 1960.*

Table 2.—**Area of commercial forest land by ownership classes, Arizona, 1962**

Ownership class	Thousand acres
National Forest	2,630
Other Federal:	
Bureau of Land Management	2
Indian	1,144
Miscellaneous Federal	—
Total other Federal	1,146
State	32
County and municipal	2
Farmer-owned	82
Miscellaneous private[1]	85
All ownerships	3,977

[1] *Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 3.—**Area of commercial forest land by stand-size and ownership classes, Arizona, 1962**

Stand-size class	All ownerships	National Forest	Other Public	Farmer[1] and misc. private
	Thousand acres			
Sawtimber stands:				
Old growth sawtimber	1,957	1,110	804	43
Young growth sawtimber	1,786	1,346	347	93
Total	3,743	2,456	1,151	136
Poletimber stands	128	93	21	14
Sapling and seedling stands	41	20	4	17
Nonstocked area	65	61	4	—
All classes	3,977	2,630	1,180	167

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 4.—**Area of commercial forest land, by stand-volume classes for sawtimber and other stand-size classes, Arizona, 1962**

Stand volume per acre[1]	Area by stand-size classes		
	All stands	Sawtimber stands	Other stands
	- - - *Thousand acres* - - -		
Less than 1,500 board feet	243	44	199
1,500 to 5,000 board feet	1,771	1,736	35
5,000 to 10,000 board feet	1,315	1,315	—
10,000 to 20,000 board feet	433	433	—
More than 20,000 board feet	215	215	—
All classes	3,977	3,743	234

[1] *Net volume, International 1/4-inch rule.*

Table 5.—**Area of commercial forest land, by stocking classes of all live trees and by stand-size classes, Arizona, 1962**

Stocking class	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	- - - - - - - - *Thousand acres* - - - - - - - -				
70 percent or more	1,638	1,615	13	10	xx
40 to 70 percent	1,647	1,581	43	23	xx
10 to 40 percent	627	547	72	8	xx
Less than 10 percent	65	xx	xx	xx	65
All classes	3,977	3,743	128	41	65

Table 6.—**Area of commercial forest land, by forest types and ownership classes, Arizona, 1962**

Forest type	All ownerships	Public ownerships	Private ownerships
	- - - - *Thousand acres* - - - -		
Douglas-fir	130	130	—
Ponderosa pine	3,658	3,515	143
Fir-spruce	110	110	—
Aspen	79	55	24
All types	3,977	3,810	167

Table 7.—**Area of commercial forest land by forest types and by stand-size classes, Arizona, 1962**

Forest type	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Nonstocked stands
	- - - - - - - -	- Thousand acres -	- - - - - - -		
Douglas-fir	130	130	([1])	([1])	—
Ponderosa pine	3,658	3,468	89	37	64
Fir-spruce	110	109	([1])	—	1
Aspen	79	36	39	4	—
All types	3,977	3,743	128	41	65

[1] *Less than 0.5 thousand acres.*

Table 8.—**Area of noncommercial forest land, by forest types, Arizona, 1962**

Forest type	All areas	Productive reserved areas	Unproductive areas
	- - - - - -	- Thousand acres -	- - - - - -
Douglas-fir	7	7	—
Ponderosa pine	624	345	279
Fir-spruce	1	1	—
Chaparral	3,728	—	3,728
Pinyon-juniper	12,249	—	12,249
Other	12	—	12
All types	16,621	353	16,268

Table 9.—**Number of growing-stock trees on commercial forest land, by diameter classes and by softwoods, and hardwoods, Arizona, 1962**

D.B.H. class (inches)	All species	Softwood	Hardwood
	- - - - - - -	- Thousand trees -	- - - - - - -
1.0-2.9	499,297	489,428	9,869
3.0-4.9	258,648	241,092	17,556
5.0-6.9	137,699	124,954	12,745
7.0-8.9	79,912	75,891	4,021
9.0-10.9	45,015	43,092	1,923
11.0-12.9	31,597	31,126	471
13.0-14.9	20,823	20,146	677
15.0-16.9	16,232	15,791	441
17.0-18.9	10,797	10,651	146
19.0-28.9	25,710	25,636	74
29.0-38.9	3,326	3,326	—
39.0 and larger	276	276	—
All classes	1,129,332	1,081,409	47,923

Table 10.—**Volume of timber on commercial forest land, by class of timber and by softwoods and hardwoods, Arizona, 1962**

Class of timber	All species	Softwoods	Hardwoods
		Thousand cubic feet	
Sawtimber trees:			
Saw-log portion	5,148,202	5,108,355	39,847
Upper-stem portion	385,732	378,302	7,430
Total	5,533,934	5,486,657	47,277
Poletimber trees	557,257	480,548	76,709
All growing-stock trees	6,091,191	5,967,205	123,986
Sound cull trees:			
Sawtimber-size trees	115,651	56,935	58,716
Poletimber-size trees	106,152	31,176	74,976
Total	221,803	88,111	133,692
Rotten cull trees:			
Sawtimber-size trees	82,049	39,287	42,762
Poletimber-size trees	45,459	6,170	39,289
Total	127,508	45,457	82,051
Salvable dead trees:			
Sawtimber-size trees	360,341	359,922	419
Poletimber-size trees	17,117	9,071	8,046
Total	377,458	368,993	8,465
All timber	6,817,960	6,469,766	348,194

Table 11.—**Volume of growing stock and sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Arizona, 1962**

Ownership class	All species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
National Forest	4,389	4,345	44
Other public	1,556	1,512	44
Farmer and misc. private[1]	146	110	36
All ownerships	6,091	5,967	124
		SAWTIMBER *(Million board feet)*[2]	
National Forest	19,153	19,105	48
Other public	7,297	7,203	94
Farmer and misc. private[1]	501	384	117
All ownerships	26,951	26,692	259

[1] *Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *International 1/4-inch rule.*

Table 12.—Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, Arizona, 1962

Stand-size class	All species	Softwoods	Hardwoods
		GROWING STOCK *(Million cubic feet)*	
Sawtimber stands	5,949	5,892	57
Poletimber stands	136	69	67
Sapling and seedling stands	5	5	—
Nonstocked areas	1	1	—
All classes	6,091	5,967	124
		SAWTIMBER *(Million board feet)*[1]	
Sawtimber stands	26,694	26,529	165
Poletimber stands	238	144	94
Sapling and seedling stands	16	16	—
Nonstocked areas	3	3	—
All classes	26,951	26,692	259

[1] *International 1/4-inch rule.*

Table 13.—Volume of growing stock on commercial forest land by species and diameter classes, Arizona, 1962

Species	Diameter class (inches at breast height)										
	All classes	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-28.9	29.0-38.9	39.0 & larger
	Million cubic feet										
Softwoods:											
Douglas-fir	283	9	7	10	10	10	18	21	109	58	31
Ponderosa pine[1]	5,204	173	235	216	312	319	426	581	2,313	594	35
Limber pine[2]	39	1	2	1	2	5	4	3	16	3	2
True firs[3]	210	21	15	10	16	15	17	12	63	30	11
Engelmann spruce	231	6	11	9	20	27	29	31	88	10	—
Total	5,967	210	270	246	360	376	494	648	2,589	695	79
Hardwoods:											
Aspen	124	34	24	19	8	15	14	6	4	—	—
Total	124	34	24	19	8	15	14	6	4	—	—
All species:	6,091	244	294	265	368	391	508	654	2,593	695	79

[1] *Includes a negligible amount of Apache, Arizona, and Chihuahua pine.*
[2] *Includes a negligible amount of Mexican white and bristlecone pines.*
[3] *Includes subalpine, white, and corkbark firs.*

Table 14.—**Volume of sawtimber on commercial forest land, by species and diameter classes, Arizona, 1962**

Species	Diameter class (inches at breast height)								
	All classes	9.0-10.9[1]	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-28.9	29.0-38.9	39.0 & larger
	Million board feet[2]								
Softwoods:									
Douglas-fir	1,476	48	56	51	91	103	613	340	174
Ponderosa pine[3]	22,883	920	1,354	1,397	1,890	2,585	11,079	3,389	269
Limber pine[4]	186	7	10	25	19	15	82	18	10
True firs[5]	932	48	78	77	88	62	349	167	63
Engelmann spruce	1,215	50	111	150	162	173	510	59	—
Total	26,692	1,073	1,609	1,700	2,250	2,938	12,633	3,973	516
Hardwoods:									
Aspen	259	—	40	85	78	34	22	—	—
Total	259	—	40	85	78	34	22	—	—
All species	26,951	1,073	1,649	1,785	2,328	2,972	12,655	3,973	516

[1] *Softwoods only.*
[2] *International 1/4-inch rule.*
[3] *Includes a negligible amount of Arizona, Apache, and Chihuahua pine.*
[4] *Includes a negligible amount of Mexican white and bristlecone pines.*
[5] *Includes subalpine, white, and corkbark firs.*

Table 15.—**Volume of sawtimber on commercial forest land, by species[1] and quality classes, Arizona, 1962**

Species	Quality classes				
	All classes	1	2	3	4
	Million board feet[2]				
Softwoods:					
Ponderosa pine[3]	22,883	533	856	2,021	19,473
Total	22,883	533	856	2,021	19,473

[1] *Ponderosa pine is the only species log-graded.*
[2] *International 1/4-inch rule.*
[3] *Includes a negligible amount of Arizona, Apache, and Chihuahua pine.*

Table 16.—**Volume of salvable dead sawtimber-size trees on commercial forest land, by softwoods and hardwoods, Arizona, 1962**

Species group	Volume
	Thousand board feet[1]
Softwoods	1,674,663
Hardwoods	2,287
All species	1,676,950

[1] *International 1/4-inch rule.*

Table 17.—**Net annual growth and annual cut of growing stock on commercial forest land, by species, Arizona, 1962**

Species	Net annual growth	Annual timber cut
	Thousand cubic feet	
Softwoods:		
Douglas-fir	– 1,398	4,115
Ponderosa pine[1]	84,669	57,558
Limber pine[2]	693	85
True firs[3]	289	3,142
Engelmann spruce	2,348	845
Total	86,601	65,745
Hardwoods:		
Aspen	3,652	196
All species	90,253	65,941

[1] *Includes a negligible amount of Arizona, Apache, and Chihuahua pines.*

[2] *Includes a negligible amount of Mexican white and bristlecone pines.*

[3] *Includes subalpine, white, and corkbark firs.*

Table 18.—**Annual cut of growing stock on commercial forest land, by ownership classes and by softwoods and hardwoods, Arizona, 1962**

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
	- - - - - - - - -	*Thousand cubic feet*	- - - - - - - - -	
Softwoods	65,745	47,862	11,177	6,706
Hardwoods	196	143	33	20
All species	65,941	48,005	11,210	6,726

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

Table 19.—**Net annual growth and annual cut of sawtimber on commercial forest land, by species, Arizona, 1962**

Species	Net annual growth	Annual timber cut
	Thousand board feet[1]	
Softwoods:		
Douglas-fir	–11,626	25,481
Ponderosa pine[2]	340,022	353,899
Limber pine[3]	2,572	404
True firs[4]	–1,890	19,414
Engelmann spruce	12,665	5,258
Total	341,743	404,456
Hardwoods:		
Aspen	2,335	394
All species	344,078	404,850

[1] *International 1/4-inch rule.*

[2] *Includes a negligible amount of Arizona, Apache, and Chihuahua pines.*

[3] *Includes a negligible amount of Mexican white and bristlecone pines.*

[4] *Includes subalpine, white, and corkbark firs.*

Table 20.—**Annual cut of sawtimber on commercial forest land, by ownership classes and by softwoods and hardwoods, Arizona, 1962**

Species group	All ownerships	National Forest	Other public	Farmer[1] and misc. private
	Thousand board feet[2]			
Softwoods	404,456	294,444	68,757	41,255
Hardwoods	394	287	67	40
All species	404,850	294,731	68,824	41,295

[1] *Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.*

[2] *International 1/4-inch rule.*

Table 21.—**Annual mortality of growing stock and sawtimber on commercial forest land, by species, Arizona, 1962**

Species	Growing stock	Sawtimber
	Thousand cubic feet	*Thousand board feet*[1]
Softwoods:		
Douglas-fir	5,176	30,591
Ponderosa pine[2]	12,246	63,741
True firs[3]	3,257	15,320
Engelmann spruce	71	—
Total	20,750	109,652
Hardwoods:		
Aspen	1,044	3,851
All species	21,794	113,503

[1] *International 1/4-inch rule.*

[2] *Includes a negligible amount of Arizona, Apache, and Chihuahua pines.*

[3] *Includes subalpine, white, and corkbark firs.*

Table 22.—**Annual mortality of growing stock and sawtimber on commercial forest land, by causes and by softwoods and hardwoods, Arizona, 1962**

Cause of death	Growing stock			Sawtimber		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	- - - *Thousand cubic feet* - - -			- - - *Thousand board feet*[1] - - -		
Fire	8,619	8,619	—	45,830	45,830	—
Insects	2,564	2,564	—	11,596	11,596	—
Disease	7,703	7,283	420	44,358	42,635	1,723
Other	1,450	826	624	6,339	4,211	2,128
Weather	1,458	1,458	—	5,380	5,380	—
All causes	21,794	20,750	1,044	113,503	109,652	3,851

[1] *International 1/4-inch rule.*

Table 23.—**Total output of timber products, by products, by type of material used, and by softwoods and hardwoods, Arizona, 1962**

Product and species group	Total output in standard units		Output from roundwood from growing stock		Output from roundwood from nongrowing stock		Output from plant by-products (standard units)
	Unit	Number	Standard units	M cubic feet	Standard units	M cubic feet	
Saw logs:							
Softwood	M bd. ft.[1]	341,757	330,137	47,870	11,620	1,685	—
Hardwood	M bd. ft.[1]	—	—	—	—	—	—
Total	M bd. ft.[1]	341,757	330,137	47,870	11,620	1,685	—
Pulpwood:							
Softwood	M std. cds.	88	88	7,947	—	—	—
Hardwood	M std. cds.	—	—	—	—	—	—
Total	M std. cds.	88	88	7,947	—	—	—
Poles:							
Softwood	M pcs.	9	9	125	—	—	—
Hardwood	M pcs.	—	—	—	—	—	—
Total	M pcs.	9	9	125	—	—	—
Mine timbers:							
Softwood	M cu. ft.	556	524	524	32	32	—
Hardwood	M cu. ft.	—	—	—	—	—	—
Total	M cu. ft.	556	524	524	32	32	—
Miscellaneous industrial wood:[2]							
Softwood	M cu. ft.	111	82	82	29	29	—
Hardwood	M cu ft.	375	196	196	179	179	—
Total	M cu. ft.	486	278	278	208	208	—
Posts:							
Softwood	M pcs.	171	31	25	140	112	—
Hardwood	M pcs.	2	—	—	2	2	—
Total	M pcs.	173	31	25	142	114	—
Fuelwood:							
Softwood	M std. cds.	94	5	353	75	5,197	14
Hardwood	M std. cds.	17	—	—	17	1,171	—
Total	M std. cds.	111	5	353	92	6,368	14
All products:							
Softwood	M cu. ft.	—	—	56,926	—	7,055	—
Hardwood	M cu. ft.	—	—	196	—	1,352	—
Total	M cu. ft.	—	—	57,122	—	8,407	—

[1] *International 1/4-inch rule.*

[2] *Includes converter poles, excelsior bolts, charcoal wood, house logs, and miscellaneous farm timbers.*

Table 24.—**Total output of roundwood products, by source and by softwoods and hardwoods, Arizona, 1962**

Source	All species	Softwoods	Hardwoods
	- - - *Thousand*	*cubic feet*	- - -
Growing-stock trees:[1]			
Sawtimber	56,930	56,812	118
Poletimber	192	114	78
Total	57,122	56,926	196
Cull trees[1]	—	—	—
Salvable dead trees[1]	7,455	6,537	918
Other[2]	952	518	434
All sources	65,529	63,981	1,548

[1] *On commercial forest land.*

[2] *Includes noncommercial forest land, nonforest land such as fence rows, trees less than 5.0 inches in diameter, and tree tops and limbs.*

Table 25.—**Annual timber cut from growing stock on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Arizona, 1962**

Products and residues	All species	Softwoods	Hardwoods
	- - - *Thousand*	*cubic feet*	- - -
Roundwood products:			
Saw logs	47,870	47,870	—
Pulpwood	7,947	7,947	—
Poles	125	125	—
Mine timbers	524	524	—
Miscellaneous industrial wood[1]	278	82	196
Posts	25	25	—
Fuelwood	353	353	—
All products	57,122	56,926	196
Logging residues	8,819	8,819	—
Timber cut	65,941	65,745	196

[1] *Includes converter poles, excelsior bolts, charcoal wood, house logs, and miscellaneous farm timbers.*

Table 26.—**Annual timber cut from live sawtimber on commercial forest lands, by products and logging residues, and by softwoods and hardwoods, Arizona, 1962**

Products and residues	All species	Softwoods	Hardwoods
	- - - *Thousand board feet*[1] - - -		
Roundwood products:			
Saw logs	330,137	330,137	—
Pulpwood	54,834	54,834	—
Poles	862	862	—
Mine timbers	1,790	1,790	—
Miscellaneous industrial wood[2]	559	165	394
Posts	77	77	—
Fuelwood	390	390	—
All products	388,649	388,255	394
Logging residues	16,201	16,201	—
Timber cut	404,850	404,456	394

[1] *International 1/4-inch rule.*

[2] *Includes converter poles, excelsior bolts, charcoal wood, house logs, and miscellaneous farm timbers.*

Table 27.—**Volume of plant residues by industrial source and type of residue, and by softwoods and hardwoods, Arizona, 1962**

Industrial source	Species and character of residues								
	All species			Softwoods			Hardwoods		
	Total	Coarse[1]	Fine[2]	Total	Coarse	Fine	Total	Coarse	Fine
	- - - - - - - - - - - - - *Thousand cubic feet* - - - - - - - - - - - - -								
Lumber industry	10,268	3,896	6,372	10,268	3,896	6,372	—	—	—
Veneer and plywood industry	0	0	0	0	0	0	0	0	0
Other primary industries	103	103	—	21	21	—	82	82	—
All industries	10,371	3,999	6,372	10,289	3,917	6,372	82	82	—

[1] *Unused material suitable for chipping, such as slabs, edgings, and veneer cores.*

[2] *Unused material not suitable for chipping, such as sawdust and shavings.*

Table 28.—**Timber growth projections, all species, Arizona, 1962-92**[1]

Year	Assumed cut	Projected growth
	GROWING STOCK *(Thousand cubic feet)*	
1962	65,941	90,253
1972	86,700	112,200
1982	103,400	131,200
1992	117,700	149,100
	SAWTIMBER *(Thousand board feet)*[2]	
1962	404,850	344,078
1972	444,600	381,400
1982	468,100	408,800
1992	479,600	419,200

---

[1] *These projections assume that: (1) There will be practically no change in the area of commercial forest land, (2) demands for timber products will rise along with predicted increases in the nation's population and income, (3) timber will maintain its market position relative to competing materials, and (4) timber management will become more intensive, especially with respect to improving the number, spacing, vigor, and age-class distribution of trees.*

[2] *International 1/4-inch rule.*

Map

of

Major Forest Types

in

Arizona

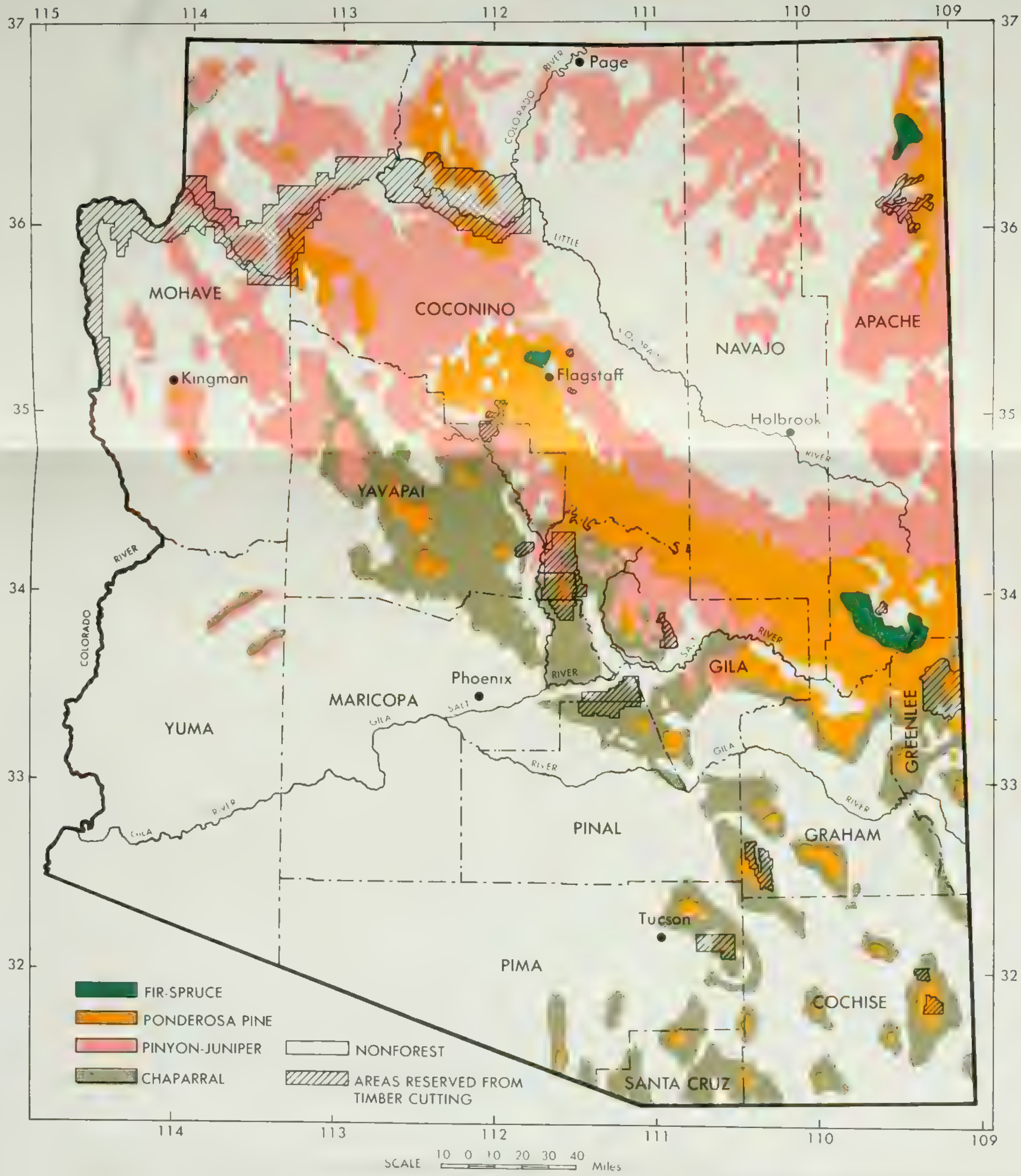
1964

MAJOR FOREST TYPES

ARIZONA

1964

FOREST SURVEY ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
AND
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION



RECENT FOREST SURVEY PUBLICATIONS

Title	Number	Date
Timber Resources of Idaho	Forest Survey Release No. 3	1962
The Forest Resources of Western Montana	Resource Bulletin INT-1	1963
*The Forests of Wyoming	Resource Bulletin INT-2	1963
*The Forest Resources of Colorado	Resource Bulletin INT-3	1964
Output of Timber Products in Montana, 1962	Research Paper INT-11	1964
Forest Products Output in Utah and Nevada, 1962	Research Paper INT-12	1964
Output of Timber Products in Idaho, 1962	Research Paper INT-13	1964
*Timber Products Output in Colorado, Wyoming, and Western South Dakota	Research Paper INT-14	1964
*Timber Products Output in Arizona and New Mexico, 1962	Research Paper INT-15	1964
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Site Index Curves for Engelmann Spruce in the Northern and Central Rocky Mountains	Research Note INT-42	1966
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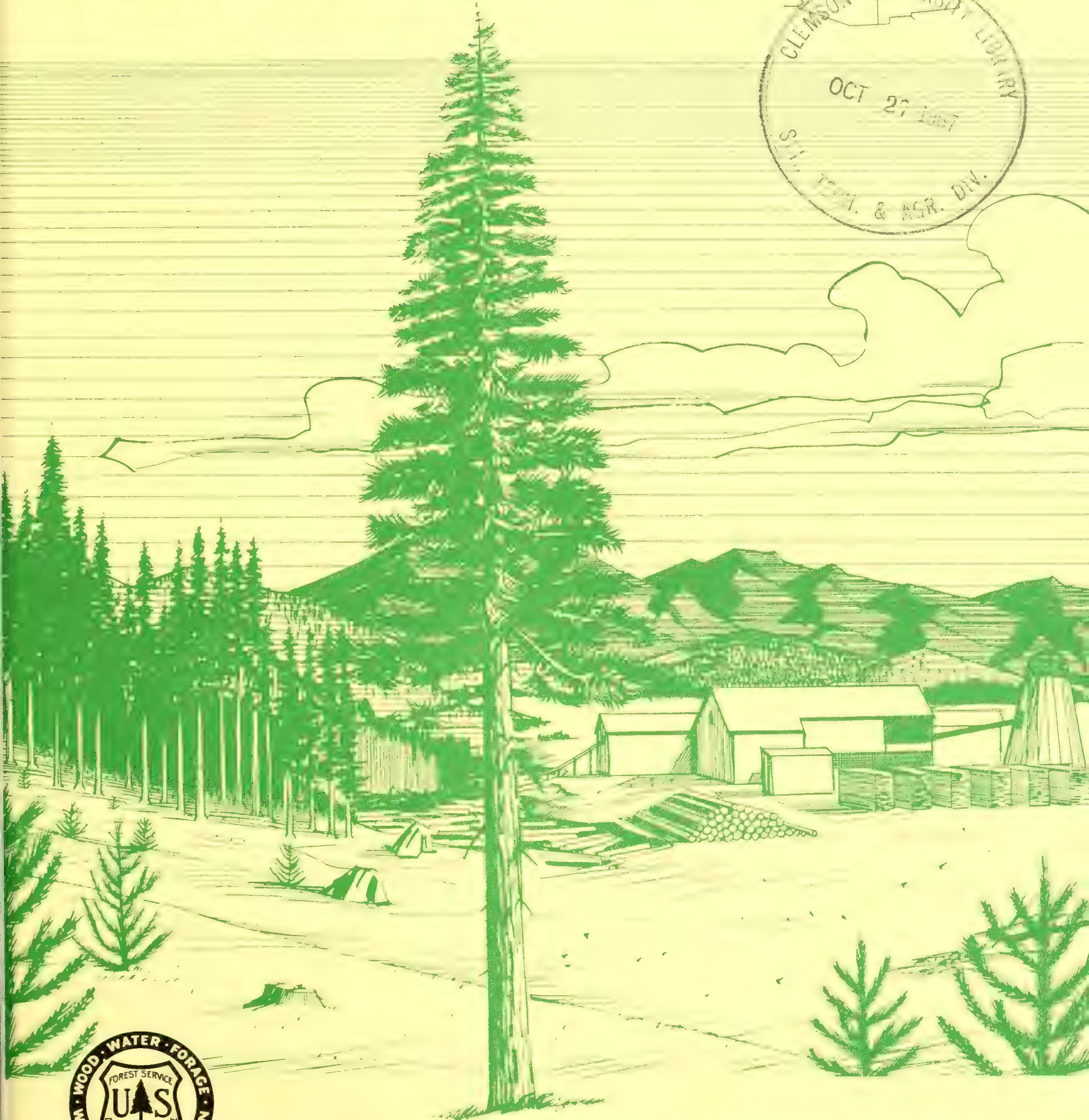

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TIMBER RESOURCES AND INDUSTRIES IN THE ROCKY MOUNTAIN STATES

Alvin K. Wilson

and

John S. Spencer, Jr.

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
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Joseph F. Pechanec, Director

FOREWORD

This report presents the most complete set of statistics on timber inventory, cut, and timber products output that has ever been prepared for the Rocky Mountain States[1] as a whole. Some of the material has already been published in reports for individual States or portions of States. This report discusses past trends in timber industries and the importance of timber industries in the economy of the Mountain States, but does not attempt to project or analyze the data in terms of possible future developments. However, this report does provide much of the basic resource and timber industry data necessary for anyone looking into future possibilities. The Bibliography, page 50, contains a listing of the most recent and pertinent literature concerning the problems of and opportunities for timber-oriented industrial developments in the Rocky Mountains.

Most of the inventory statistics shown here agree with those shown in "Timber Trends in the United States" (71),[2] except those for Arizona and New Mexico. Statistics for these States in the Timber Trends report are based on incomplete inventories, whereas those shown in this report result from surveys completed in 1962. However, because compilations were not finished until late 1964, these later data for Arizona were not available for the Timber Trends report. Moreover, some information shown in the industries map and presented in the text relating to pulpmill and plywood plant locations and capacities is more recent than the data shown in the tables.

Statistics from many sources have been used in compiling this report. Inventory data result from surveys made by the 59 National Forests in the Rocky Mountain States, the Intermountain Forest and Range Experiment Station, the Rocky Mountain Forest and Range Experiment Station, and the Bureau of Indian Affairs. Surveys of timber cut and timber products output were made cooperatively by the Intermountain and Rocky Mountain Forest and Range Experiment Stations. Estimates of lumber production are based on surveys by U.S. Bureau of Census.

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[1] The following are called Rocky Mountain or Mountain States in this report: Idaho, Montana, South Dakota (west of the 103d meridian), Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico.

[2] Underlined numbers in parentheses refer to publications listed in the Bibliography, page 50.

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ROCKY MOUNTAIN TIMBER AS PART OF THE NATION'S SUPPLY

This section of the report considers the timber resources of the Mountain States in comparison with those of other major sections of the United States and of the entire United States as of the beginning of 1963. Recent trends in types and capacities of timber-based industrial establishments in the Mountain States are compared with trends elsewhere in the Nation.

FOREST LANDS AND TIMBER

Under this heading, the timber resources of the Mountain section are examined and compared with those of other sections of the country in regard to forest land areas, timber volumes, land and timber ownerships, timber stand-size classes and types, and rates of timber growth and cut.

Land Areas

The Mountain section contains nearly one-fourth (24 percent) of the gross land area of the United States (fig. 1). In this respect it is roughly comparable to each of the other three main sections of the country--the North, the South, and the Pacific Coast--as recognized in this report

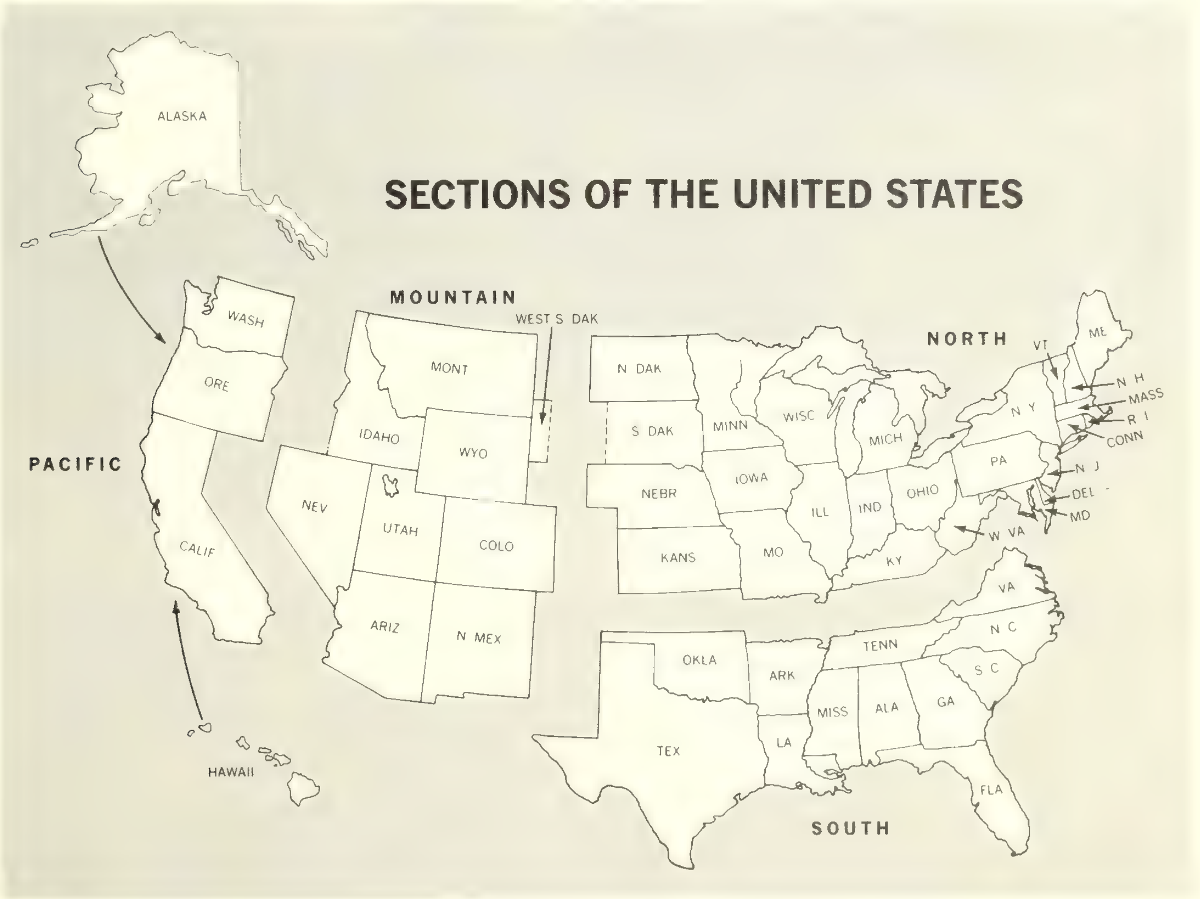
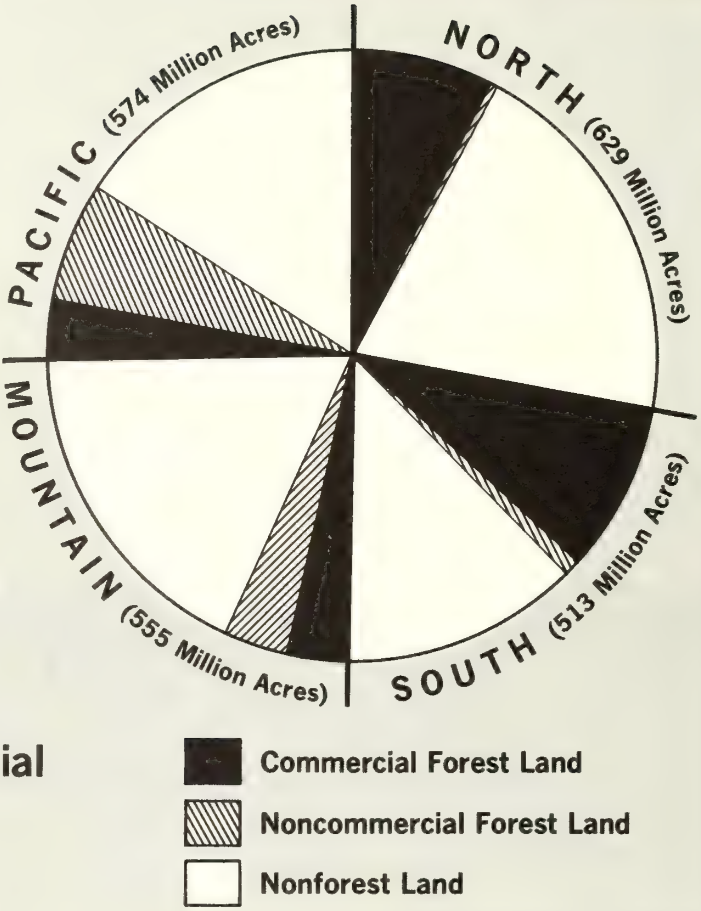


Figure 1



Major sections of the United States are about equal in land area, but . . .

the Mountain and Pacific sections have the smallest areas of commercial forest land.

Figure 2

and in the "Timber Trends in the United States" (71). In total forest land the Mountain section falls somewhat behind the other sections of the country, as the following tabulation shows:

Section	Forest land (Million acres)
North	179
South	220
Mountain	143
Pacific	217
Total	759

Mountain and Pacific Coast sections about equal in commercial forest area

The Mountain section includes some of the widest environmental extremes for plant life to be found anywhere on the continent. Therefore, it is not surprising that only 26 percent of the land area in the Mountain section is forested. This is the lowest percentage of all four sections of the country. Although the Mountain States have less forest land, they have nearly as much commercial forest land (66 million acres) as the Pacific Coast States (70 million acres),[3] as shown in figure 2.

More than half of Mountain States forest land not commercially important for timber

The "noncommercial" forest land classification includes lands that fall under one of two subclasses. Nearly 7.4 million acres (5 percent) of the forest land in the Mountain States--more than in any other section--are "productive-reserved." This means they are in parks and other areas where commercial timber operations are prohibited. Nearly 70 million acres (49 percent) of the Mountain States forest land are unsuited for commercial timber operations and are termed "unproductive."

Public ownership of commercial forest land highest in Mountain States

The contrast between the proportions of commercial forest land in public ownership in the United States as a whole and that in the Mountain States is striking. Only 28 percent of the commercial forest land of the United States is publicly owned, but in the Mountain States 77 percent is in this category. Nearly two-thirds (66 percent) of the commercial forest land in the Mountain States is in National Forests. Conversely, the Mountain States have the least acreage of commercial forest land in private ownership of any major section of the country (table 1).

Table 1.--Ownership of commercial forest land

Section	Federal		Other public	Private
	National Forests	Other		
	Million acres			
North	10	2	20	140
South	11	3	3	184
Mountain	43	5	2	15
Pacific	33	6	4	28
Total	97	16	29	367

Softwood forest types characterize commercial forest in West

Softwood forest types are predominant in the commercial forests of both the Mountain and Pacific sections. The commercial forests of the Mountain States have nearly 60 million acres of softwood types (91 percent of the commercial area), and the Pacific section has somewhat more (65 million acres, or 93 percent). The South has a greater area in softwood types (81 million acres) than either the Mountain or Pacific sections, but it has a still greater area in hardwoods (120 million acres). Consequently, the commercial forest land of this section is more characteristically hardwood than softwood (fig. 3).

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[3] Includes commercial forest land area for coastal Alaska only. Some parts of the forest land of interior Alaska are expected to meet standards for commercial forest land, but data are not yet available.

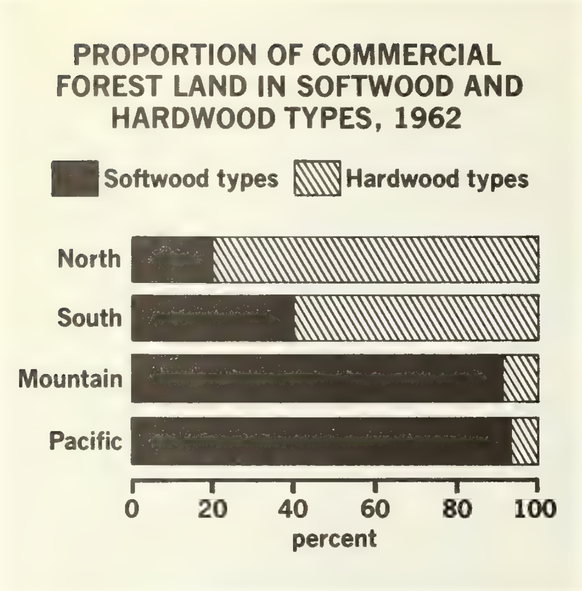

Figure 3

Mountain States commercial forest land largely in sawtimber stands

Nearly 60 percent of the Mountain States commercial forest land is in sawtimber stands; the proportion (69 percent) is even higher in the Pacific States (fig. 4). Since these sections include practically all of the old-growth sawtimber stands remaining in the United States, much attention has been given to finding methods for harvesting the old-growth and often highly defective timber. An integral part of the problem is making the transition to more intensive management while achieving an inventory that is better balanced than at present for continuous production at a high level.

Timber Inventories[4]

Mountain States have one-fifth of Nation's softwood sawtimber volume

With less than one-sixth of the total growing stock inventory of the United States, the Mountain States have more than one-fifth of the Nation's volume of softwood growing stock. The situation with respect to sawtimber inventories--total and softwood--is similar, as shown in table 2.

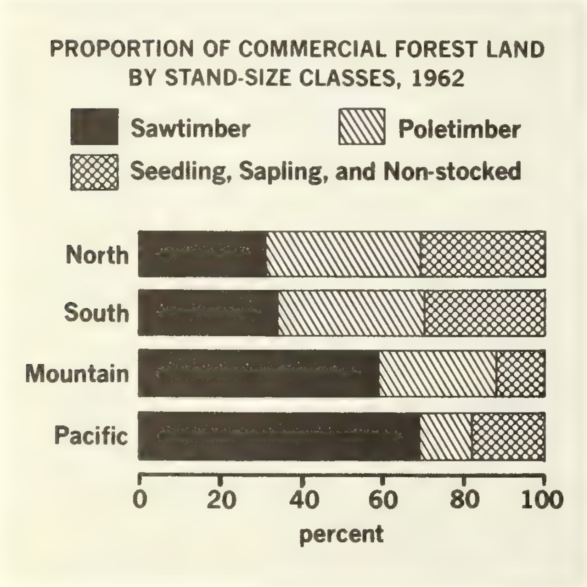

Figure 4

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[4] Throughout this report volumes of growing stock (sound, live trees 5.0 inches and larger in diameter) are given in cubic feet. Volumes of sawtimber (trees 9.0 inches and larger for softwoods, 11.0 inches and larger for hardwoods) are given in board feet.

Table 2.--Proportions of United States inventories of sawtimber and growing stock, by sections, 1962

Section	All sawtimber[1]	All growing stock[2]	Softwood sawtimber[1]	Softwood growing stock[2]
	Percent			
North	12.2	21.8	3.3	7.2
South	16.3	21.4	10.9	14.5
Mountain	16.3	15.6	19.7	21.4
Pacific	55.2	41.2	66.1	56.9
United States	100.0	100.0	100.0	100.0

[1] Board-foot basis.

[2] Cubic-foot basis.

Proportion of timber volume in public ownership highest in Mountain States

Of all four sections of the country, the Mountain section has the highest percentage of its total timber inventory in public ownership (83 percent), as shown in figure 5. This is largely due to the high proportion in National Forests (73 percent). Conversely, the Mountain States rank lowest in the percentage of forest inventory under private management. Consequently, future development of timber resources is largely dependent on management by public agencies.

Sawtimber trees account for 78 percent (75,788 M cubic feet) of the growing stock volume of the Mountain States. Although this percentage is higher elsewhere in the West--the average for the West is 85 percent--the Mountain States rank several points above the national average (73 percent).

One-fifth of the Nation's softwood sawtimber and 22 percent of the softwood growing stock are in the Mountain States. The principal softwoods are Douglas-fir, ponderosa pine, lodgepole pine, Engelmann spruce, and several species of true firs. Nearly two-thirds (63 percent) of all western white pine sawtimber and 71 percent of all western larch sawtimber are found in Idaho and Montana.

Sawtimber and growing stock volumes per acre relatively high in Mountain States

Sawtimber and growing stock volumes per acre in the Mountain States rank well above the national average and are exceeded only in the Pacific Coast section. The high proportion of sawtimber trees remaining in western stands is the main factor producing the higher averages shown by these two sections in the following comparison:

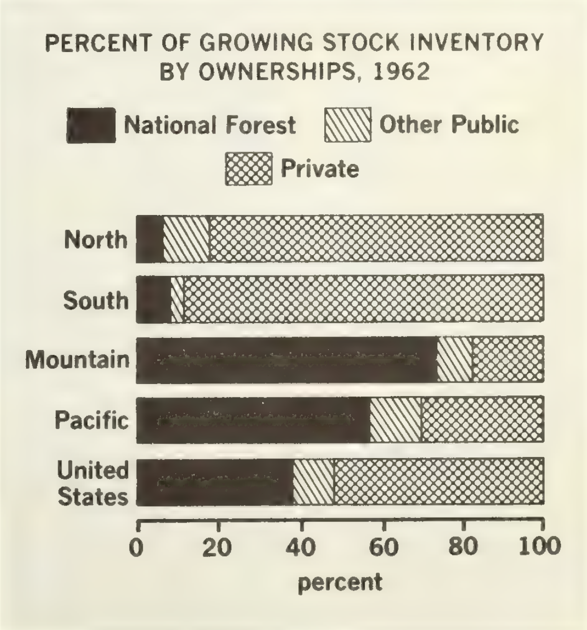


Figure 5

Section	Growing stock per acre (M cu. ft.)	Sawtimber per acre (M bd. ft.)[1]
North	0.8	1.8
South	.7	2.0
Mountain	1.5	6.3
Pacific	3.7	19.8
United States	1.2	5.0

[1] International ¼-inch log rule board-foot volumes are used throughout this report.

Growth and Cut

Timber cutting rate lowest in Mountain States

Both the highest and lowest percentages of the country's timber inventory are found in the western sections: the highest percentage in the Pacific section and the lowest in the Mountain section. Each of the eastern sections contributes more volume through growth than either of the western sections, while the South and Pacific sections (in that order) provide the highest percentages of the United States timber cut (fig. 7).

With an annual timber cut of not more than 1 percent of inventory, the Mountain States section has the lowest cutting rate in the country (fig. 8). This applies whether the cut is considered with respect to all sawtimber, all growing stock, softwood sawtimber, or softwood growing stock.

Timber growth rates are markedly higher in the eastern sections than in the western sections (fig. 9). Both the Mountain and Pacific States have large amounts of mature and overmature timber with low or even negative growth rates. These low rates depress overall growth rates for both growing stock and sawtimber. The eventual liquidation of much of this slow-growing timber will permit replacement by younger, more rapidly growing trees, and will bring about an increase in the general net growth rates.

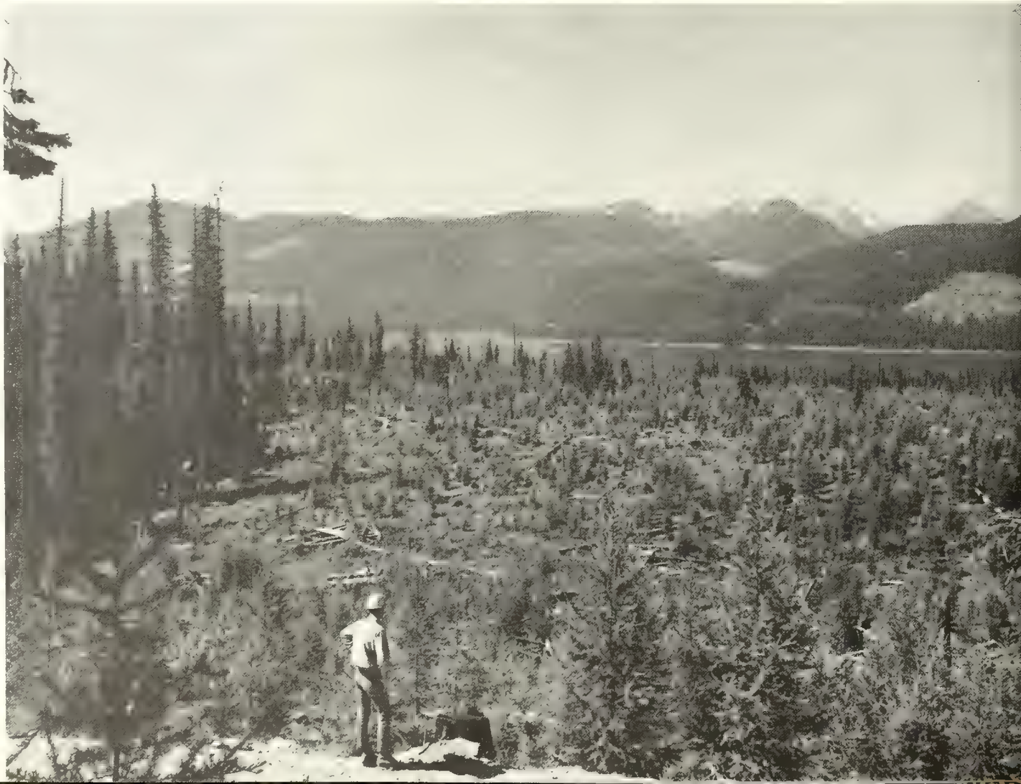
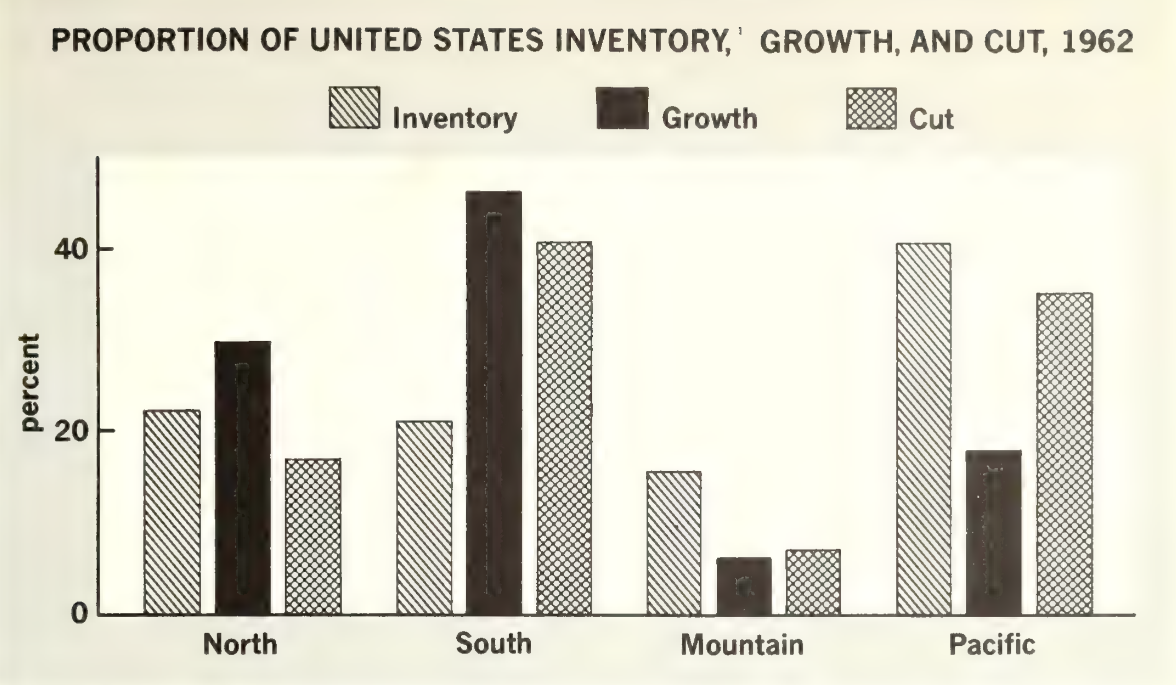


Figure 6.--A clearcut block satisfactorily regenerated with western larch saplings near Trout Lake on the Flathead National Forest in Montana. Other clearcut blocks can be seen across the lake. Even though cutting rates are low in the Mountain States, some parts of these States are cutting at or near allowable annual rates.



[1] Inventory of live, sound trees 5.0 inches and larger in diameter breast high.

Figure 7

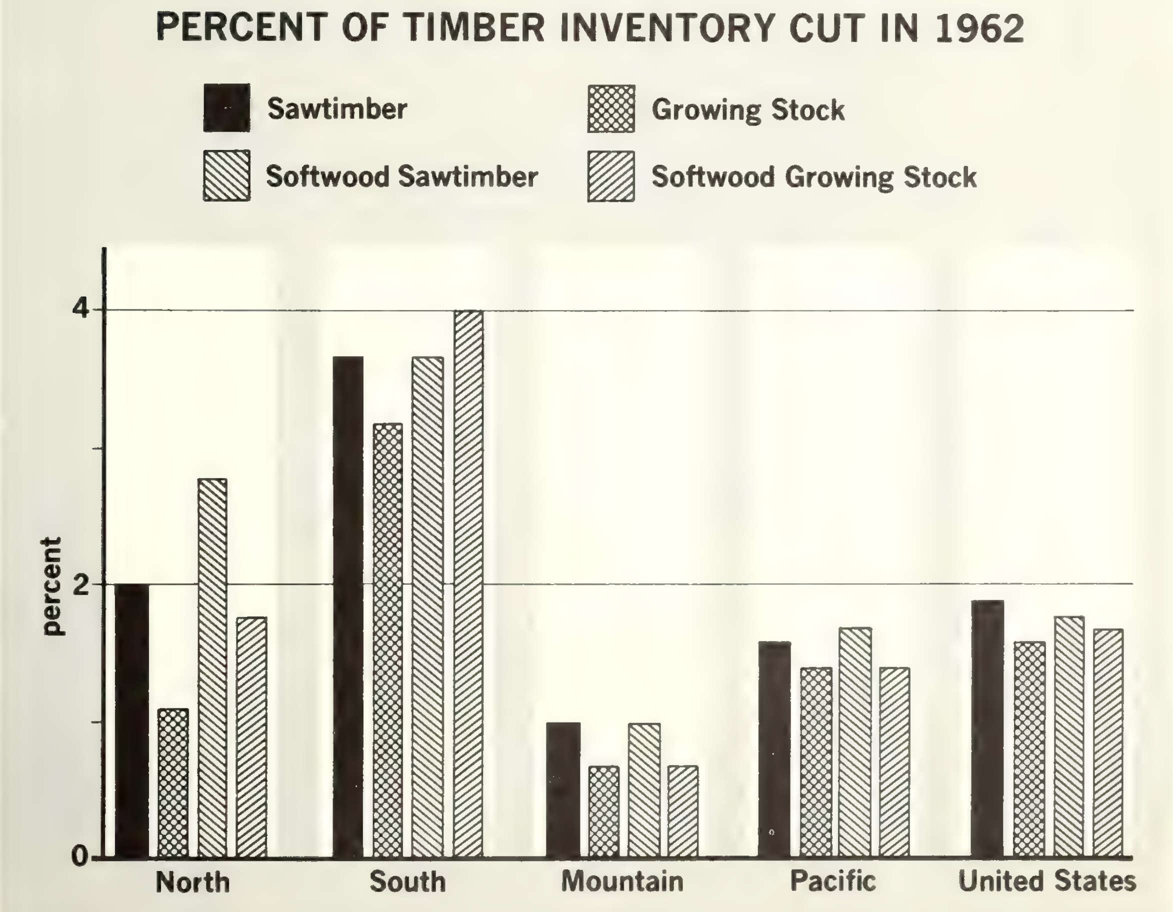


Figure 8

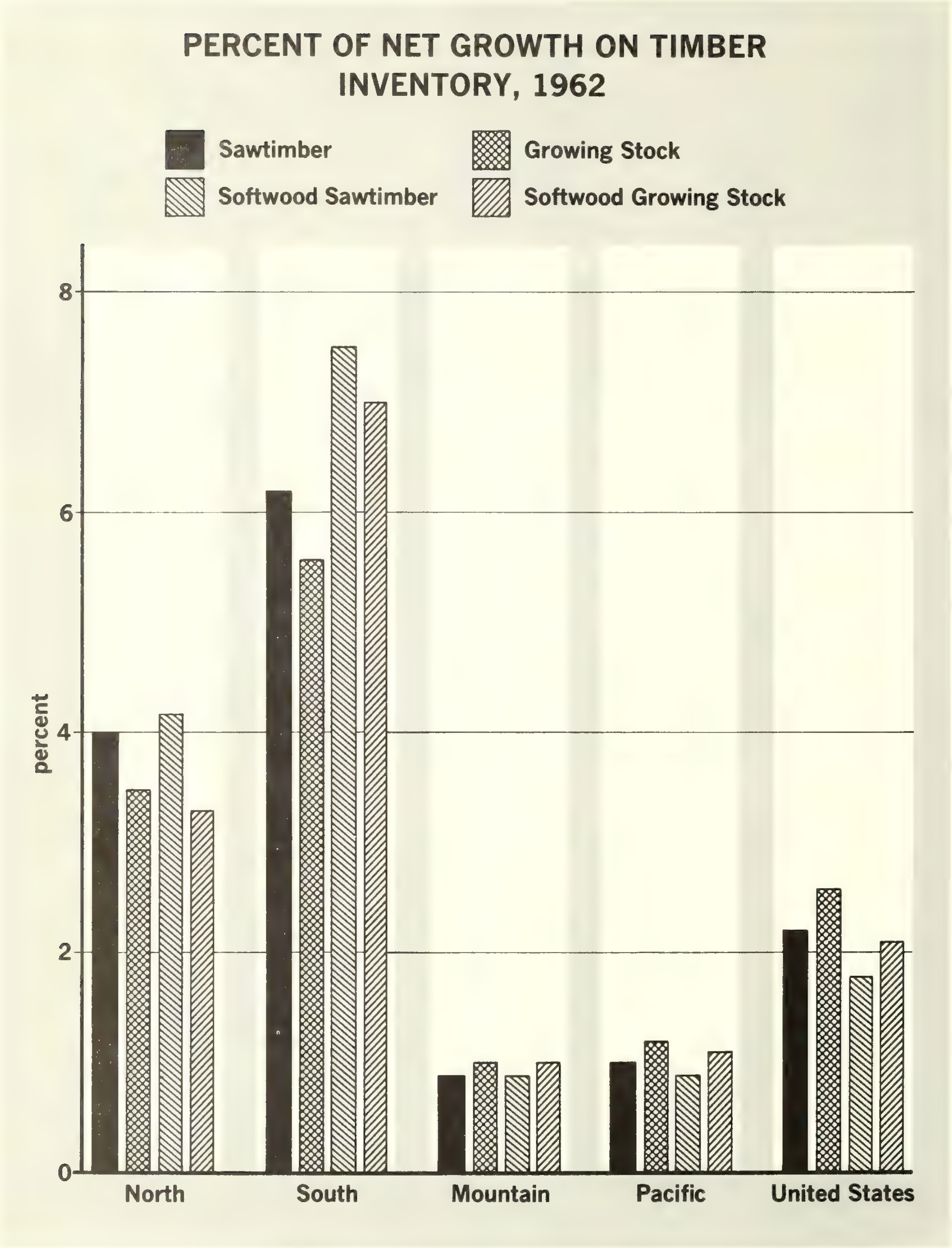

PERCENT OF NET GROWTH ON TIMBER INVENTORY, 1962
Sawtimber
Growing Stock
Softwood Sawtimber
Softwood Growing Stock
percent
8
6
4
2
0
North
South
Mountain
Pacific
United States

Figure 9

TIMBER INDUSTRIES

Comparison of the output of roundwood products in 1962 among the four major sections of the United States reemphasizes how far the Mountain States lag behind other sections in the yield of timber products. The South and Pacific sections lead the others in total roundwood production and in the production of saw logs; the Pacific section has no rival in veneer log output; the South leads in round pulpwood production; and the North and South sections lead in miscellaneous industrial wood and fuelwood (fig. 10).

Still much room for industrial development

In the Mountain States, even though timber volumes per acre are comparatively high, remoteness from principal markets and relatively high logging costs keep the cut for the area as a whole still well below the sustainable level. However, there are important exceptions to this general situation. Parts of northern Idaho and western Montana have long supported a large timber industry which was and is chiefly dependent on the sawtimber resource; they now find themselves with greater plant capacity for saw log material than can be sustained by the present sawtimber inventory under present levels of management. Saw log production in the Black Hills has been close to capacity for some time. In several other parts of the Mountain States the sawtimber cut is not far below a sustainable level. In general, however, resources suitable for other products remain untapped, particularly products such as pulpwood which can be made from trees smaller than sawtimber size. It is reasonable to expect that with a more diversified timber industry, higher total cuts could be sustained--even in areas where the cut of sawtimber is at or near the maximum that can be sustained under present management levels.

Mountain section shows strongest upward trends for all roundwood products, saw logs, and veneer logs

Comparison of some production records of the Mountain section with production records elsewhere points up some unique aspects of the position of the Mountain States in the Nation's timber economy. While the United States as a whole had a downward trend in the output of timber products from 1952 to 1962 (fig. 11), the Mountain and Pacific sections had upward trends. Of the western sections, the Mountain section showed the highest percentage increase with an output 44 percent higher in 1962 than in 1952. This is largely traceable to the fact that the Mountain section alone showed a strong increase in saw log output during this period; all other sections of the country, and the United States as a whole, showed declines in saw log output. Supporting evidence for these trends appears in Census Bureau lumber production figures. These show that from 1952 to 1964 the general lumber production trends in the North, South, and Pacific sections were downward while the Mountain section exhibited an upward trend (fig. 12).

Several explanations can be advanced for the unique rising trend in the Mountain States. Much of the difference between the Mountain States trend and those of the other sections probably arises because the Mountain States still have large inventories of sawtimber in which the allowable cut has not been reached. Here timber availability is not appreciably reduced by being tied up in large private holdings, as it is in other parts of the country.

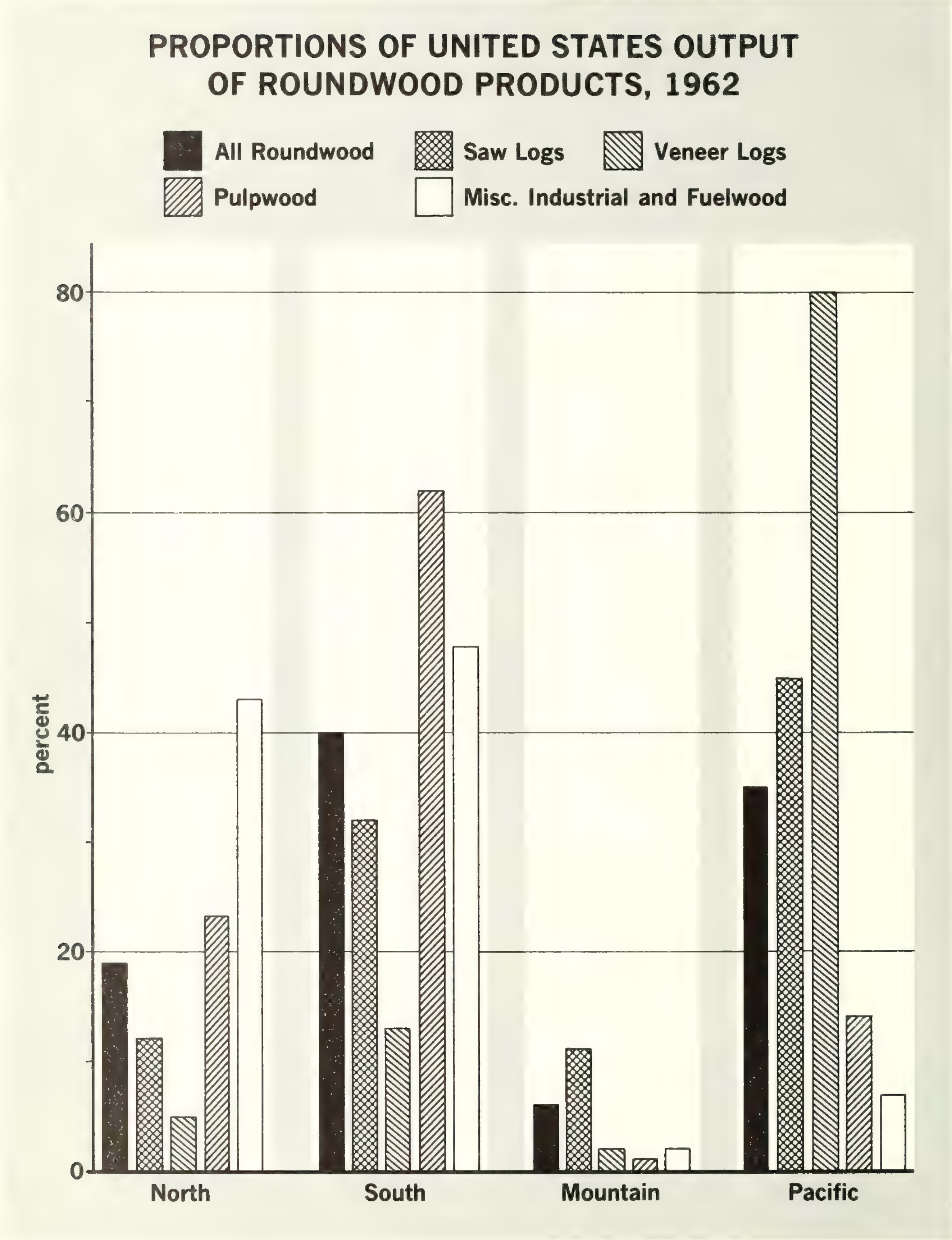

PROPORTIONS OF UNITED STATES OUTPUT OF ROUNDWOOD PRODUCTS, 1962
All Roundwood
Saw Logs
Veneer Logs
Pulpwood
Misc. Industrial and Fuelwood
80
60
40
20
0
percent
North
South
Mountain
Pacific

Figure 10

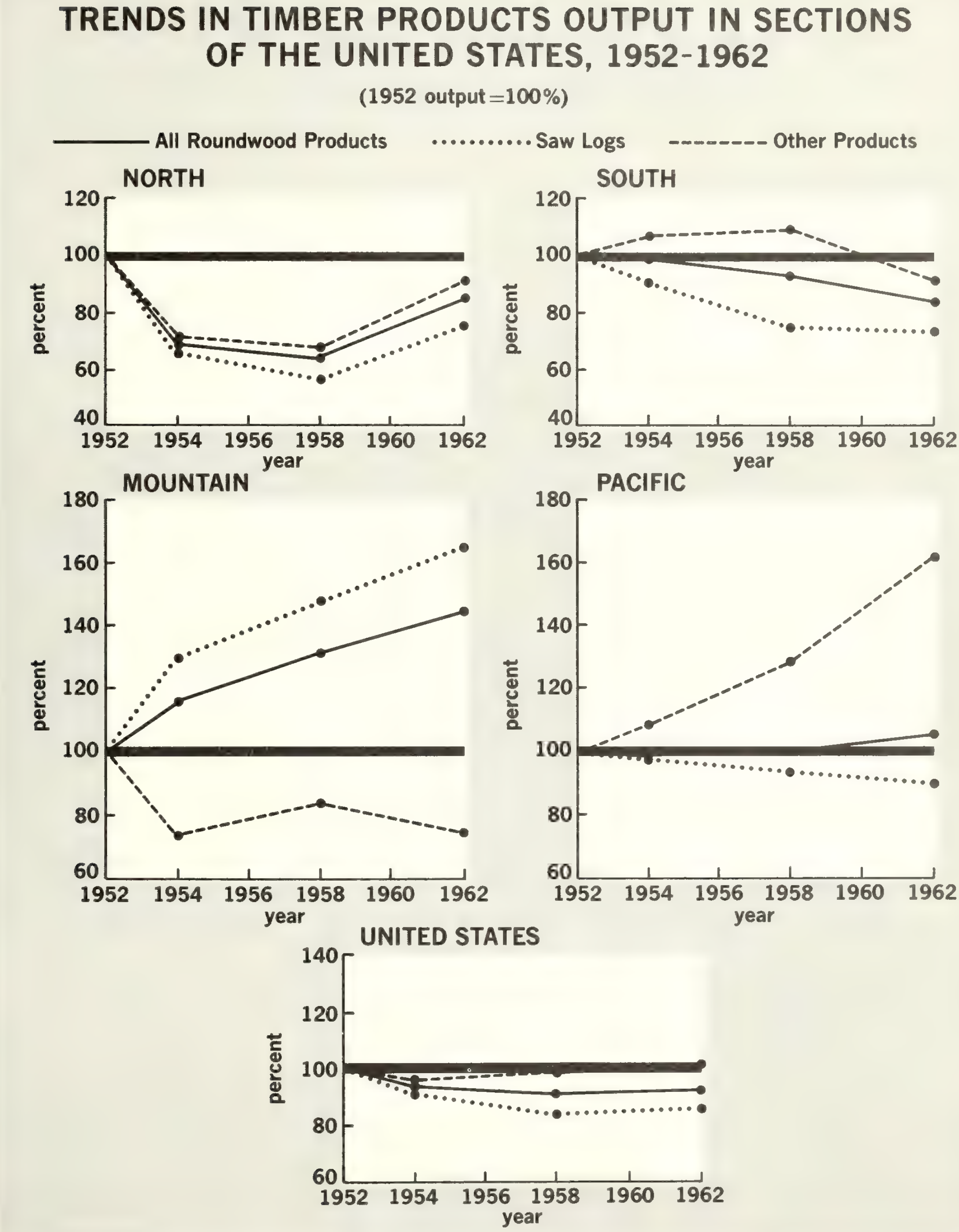

TRENDS IN TIMBER PRODUCTS OUTPUT IN SECTIONS OF THE UNITED STATES, 1952-1962
(1952 output=100%)
All Roundwood Products
Saw Logs
Other Products
NORTH
SOUTH
MOUNTAIN
PACIFIC
UNITED STATES
percent
year
40
60
80
100
120
140
160
180
1952
1954
1956
1958
1960
1962

Figure 11

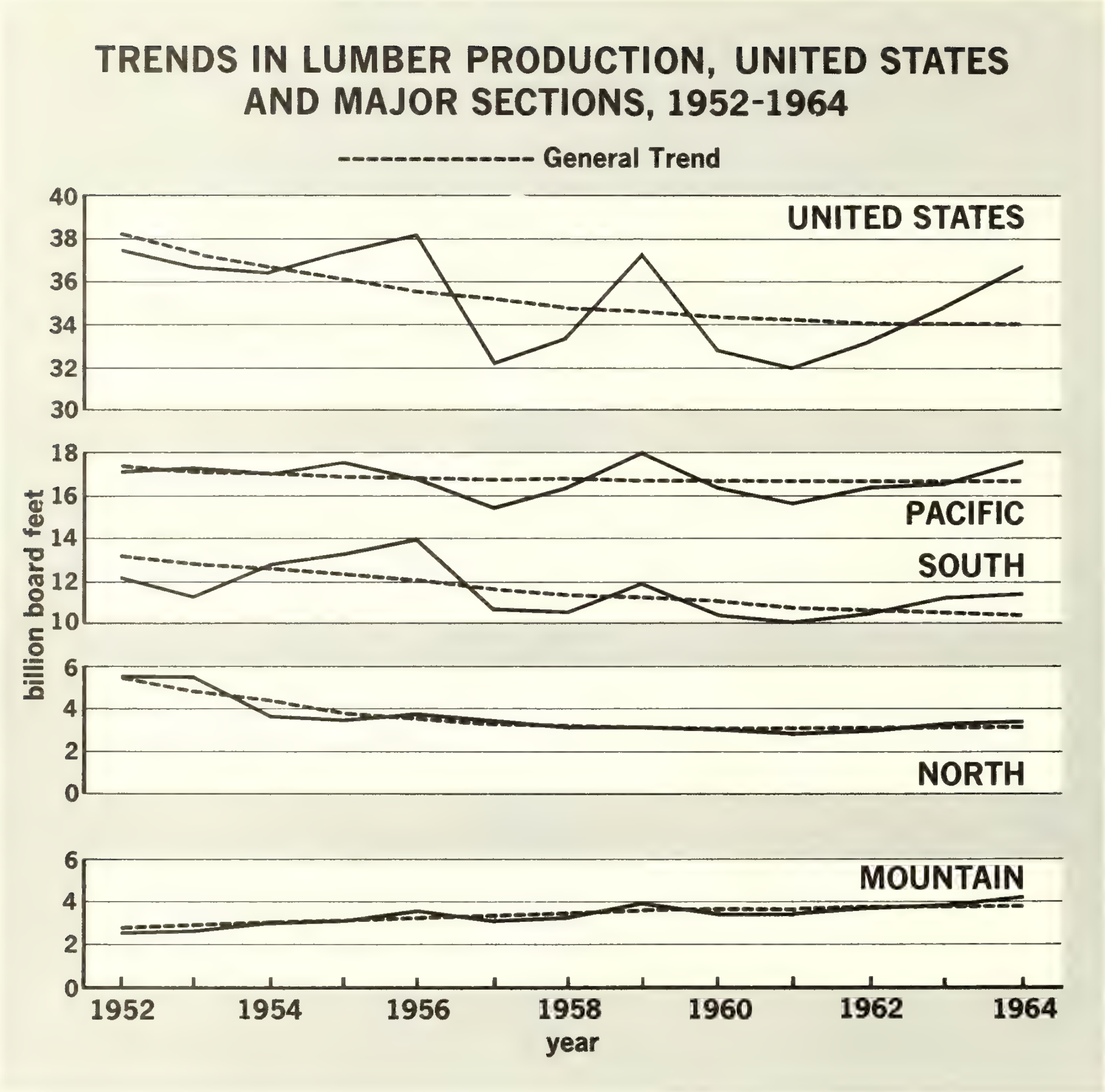


Figure 12

The continued upward trend for lumber (particularly dimension stock) in the Mountain States may also have been prompted by a need to make up, in part, a supply deficit created by temporary downward trends[5] in other parts of the country. Producers in the Mountain States could logically be expected to step in if such a situation arose, since they have always had to seek markets outside their area. Even though the Mountain States' timber industries are still strongly oriented toward lumber production, increasing amounts of wood have been and are being consumed in producing softwood plywood and pulp. However, there is still only one particle board plant in the Mountain States.

---

[5] That the trends are temporary appears to be confirmed by the upswing in lumber production in all sections of the country starting in 1961.

Although the outputs of plywood and pulp in the Mountain States have been and are relatively small parts of the national production, the rapid developments in these industries over a comparatively short period indicate the possible rate of industrial expansion in the Rockies in the near future.

As measured by the rate of increase in softwood plywood production between 1952 and 1964, the Mountain section has made remarkable gains in the output of veneer logs. This is borne out by the fact that the production of plywood in the Mountain States was 24 times larger in 1964 than in 1952. United States plywood output in 1964 was just under four times the 1952 figure.

1962 pulp production eight times that of 1952

Pulp production and pulpmill capacities have expanded greatly in the Mountain States since 1952. Wood pulp production in 1962 was eight times as great as that in 1952, and by 1965 the installed pulpmill capacity was nine times the 1952 capacity. However, there was no marked rise in the production of round pulpwood from 1952 to 1962, as practically all of the increase in pulpmill capacity and pulp production came from the growth in use of chips from sawmill residues.

Figure 13.--Loading a logging truck on a timber sale in the Coconino National Forest near Happy Jack, Arizona. Saw log output in the Mountain section increased more rapidly between 1952 and 1962 than for any other section of the country.

RELATIONSHIPS WITHIN THE ROCKY MOUNTAIN AREA

This section examines timber resources and industries in individual Rocky Mountain States and attempts to point out important comparisons between States.

THE TIMBER RESOURCE

The distribution and characteristics of the timber resource vary widely over the Rocky Mountain area because of the variety of environmental conditions. (See the map at the end of this report showing commercial forest land in the Rocky Mountain States.) The following discussion describes this forest in terms of area, timber volumes, growth, and cut.

Land Areas

Together, Montana and Idaho contain one-half the commercial forest land in Rocky Mountain States

The northern Rocky Mountain States[6] dominate much of the Rocky Mountain timber situation. And in the northern Rockies, Idaho and Montana stand out prominently. Over 70 percent of the forest land in the northern Rocky Mountain States is commercially important. By comparison, only 30 percent of forests in the southern Rockies is commercial. Montana has more area of commercial forest land (17.3 million acres) than any other Mountain State. If Idaho's 15.8 million acres of commercial forests--the second largest area in the Rockies--are added to Montana's, the total (33.1 million acres) amounts to 50 percent of the commercial forest land in the Rocky Mountain States (fig. 14). Colorado ranks third in commercial forest area with 12.3 million acres--19 percent of the Rocky Mountain total. Nevada, with only 0.2 percent of the Mountain States total, has the smallest area of commercial forests in the Mountain States. Although Montana has the largest share of commercial forest in the Rockies, Idaho has the largest proportion of its total land area in commercial forest land. Thirty percent of Idaho's land grows commercial forests. Western South Dakota, Montana, and Colorado follow, each having 19 percent of its total land in commercial forests. Nevada, with its vast area of rangeland and unproductive forests, is again lowest in the United States; only 0.2 percent of its total land area is in commercial forest.

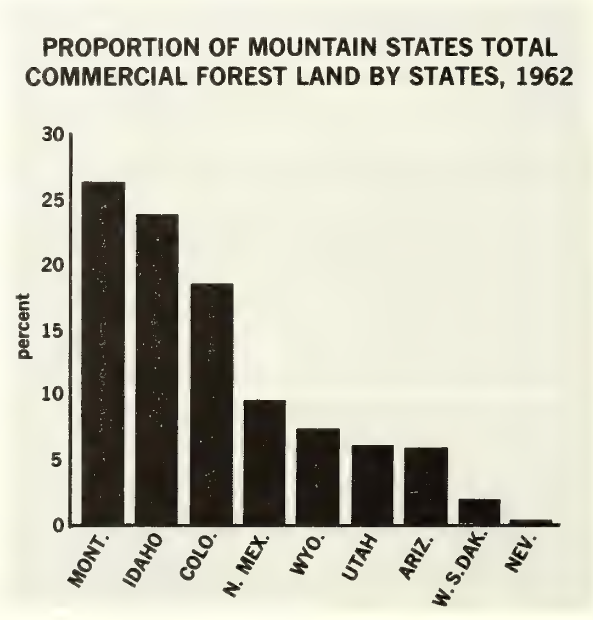

PROPORTION OF MOUNTAIN STATES TOTAL COMMERCIAL FOREST LAND BY STATES, 1962

Figure 14

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[6] In this report the northern Rocky Mountain States consist of Idaho, Montana, western South Dakota (the portion of the State west of the 103d meridian), and Wyoming. The southern Rocky Mountain States include Arizona, Colorado, Nevada, New Mexico, and Utah.

Southern Rocky Mountain States have highest proportion of noncommercial forest land

Noncommercial forest land is divided into two general categories--unproductive land and productive land that is reserved from timber harvesting. In the Rocky Mountain States there are 70.0 million acres of unproductive forest land and 7.4 million acres of productive-reserved forest land.

Eighty-five percent of the unproductive forest area is in southern Mountain States. Arizona has more unproductive forest (16.3 million acres) than any other Mountain State. Most of this unproductive land consists of 12.2 million acres of pinyon-juniper type, more than is found in any other Mountain State.

The greater part of the area in productive-reserved forests is in the northern Mountain States. Of the 7.4 million acres of this land class in the Rockies, Wyoming has 2.6 million acres--more than any other Mountain State.

Nearly three-fourths of commercial forest land is federally managed

The Federal Government administers 48.4 million acres[7] of the 65.9 million acres of commercial forest land in the Rocky Mountains. Arizona, with 95 percent of its commercial forest land in Federal management, is second only to Alaska in this respect. Idaho and Montana have the largest areas of Federal commercial forests in the Mountain States, with 11.8 million acres each. Together these two States comprise nearly one-half of the total area of the Mountain States in this ownership class. Most (90 percent) of the federally managed commercial forest in the Rockies is in National Forests.

The States own 4 percent of the commercial forest land in the Rockies. The largest area of State-owned commercial forest is in Idaho, where there are 940,000 acres in this category. Together, Idaho and Montana account for two-thirds of the State-owned commercial forest land in the Mountain States.

Twenty-three percent of the commercial forest in the Mountain States is privately owned. Most of this land is in three States--Montana, Colorado, and Idaho. The largest area is in Montana where 4.9 million acres are in private ownership; more than 1 million acres of this are owned by forest industries. The only other Mountain State having a large area of industry-owned commercial forest is Idaho where there are 1.2 million acres of such land.

Unlike any other Mountain State, Nevada has the bulk (71 percent) of its commercial forests in private ownership.

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[7] Although the Federal Government administers this land, it is not all federally owned. Indian lands, which account for 2.8 million acres of commercial forest, are under Federal trusteeship and are managed by the Bureau of Indian Affairs even though the land is private in many respects.

Sawtimber stands dominate the commercial forest

Fifty-nine percent of the commercial forest land in the Rockies supports sawtimber stands. A slightly higher proportion of sawtimber area is found in the southern Rocky Mountain States than in the northern. In particular, the Southwest[8] has the highest proportion in the Rockies. In Arizona 94 percent of the commercial forest is occupied by sawtimber stands--a higher proportion than that of any other State in the country. However, among the Rocky Mountain States, those with the largest areas of sawtimber stands are Idaho (8.7 million acres) and Montana (8.3 million acres). Despite this large area in Montana, sawtimber stands in that State represent only 48 percent of its commercial forest land--the smallest proportion of any of the Mountain States.

The imbalance of sawtimber stands to other stand-size classes, as shown in figure 16, presents problems to timber managers in the Rockies. Many sawtimber stands are over rotation age (around 120 years) and sustain high annual volume losses from insects, diseases, windthrow, and other natural causes of death. A more even distribution of age classes is desirable and should be achieved as the harvest in sawtimber stands accelerates in the Mountain States.

In Arizona and New Mexico the distribution of stand-size classes can be misleading if used to indicate the distribution of trees by age classes. The high proportions of commercial forest selectively harvested in these two States resulted in residual stands with many sawtimber trees per acre. Most of these ponderosa pine stands (the principal species in the Southwest) are classed as sawtimber because the greatest percentage of crown density is in sawtimber trees.

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[8] In this report the Southwest includes Arizona and New Mexico.

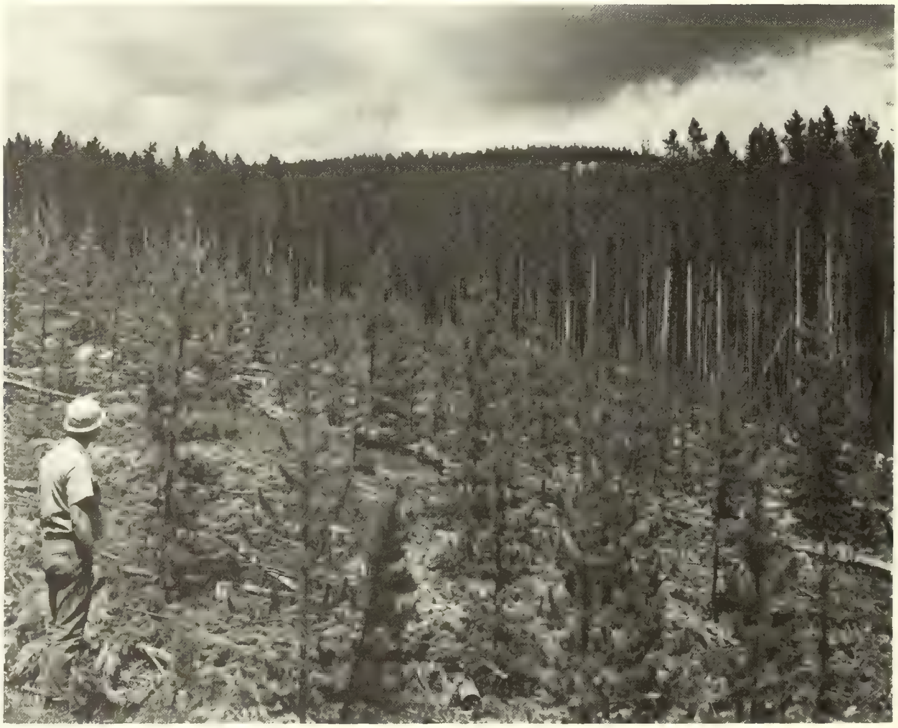

Figure 15.--The seedling-sapling stand of lodgepole pine in the foreground became established after cutting on a clearcut block in Montana's Lewis and Clark National Forest. These young trees were thinned so that the stand would not stagnate like the overstocked, mature trees in the background.

However, since substantial numbers of pole size and smaller trees are characteristically present in these stands, the problem of imbalance of age classes is not as acute as it would seem.

Nearly 80 percent of all sawtimber stands in the Mountain States is publicly owned; the highest proportion is in Arizona (96 percent) and the lowest is in Nevada (22 percent).

Nearly two-thirds of the 19 million acres of poletimber stands in the Rockies are in northern Mountain States. Montana and Colorado contain the largest areas of this stand-size class. Most of Montana's poletimber stands are made up of lodgepole pine, and many of them are stagnated and over rotation age. The best management prescription for some of these stands is to remove or destroy the existing trees and to regenerate a new stand that can be managed. In Colorado, aspen predominates in poletimber stands. Three-fourths of this stand-size class in the Rocky Mountains is publicly owned. In some parts of the Mountain States the allowable annual cut of sawtimber has been approached or reached. However, few if any areas are close to harvesting the allowable cut for all growing stock trees. For this reason much of the increase in total timber cut probably will come from poletimber trees.

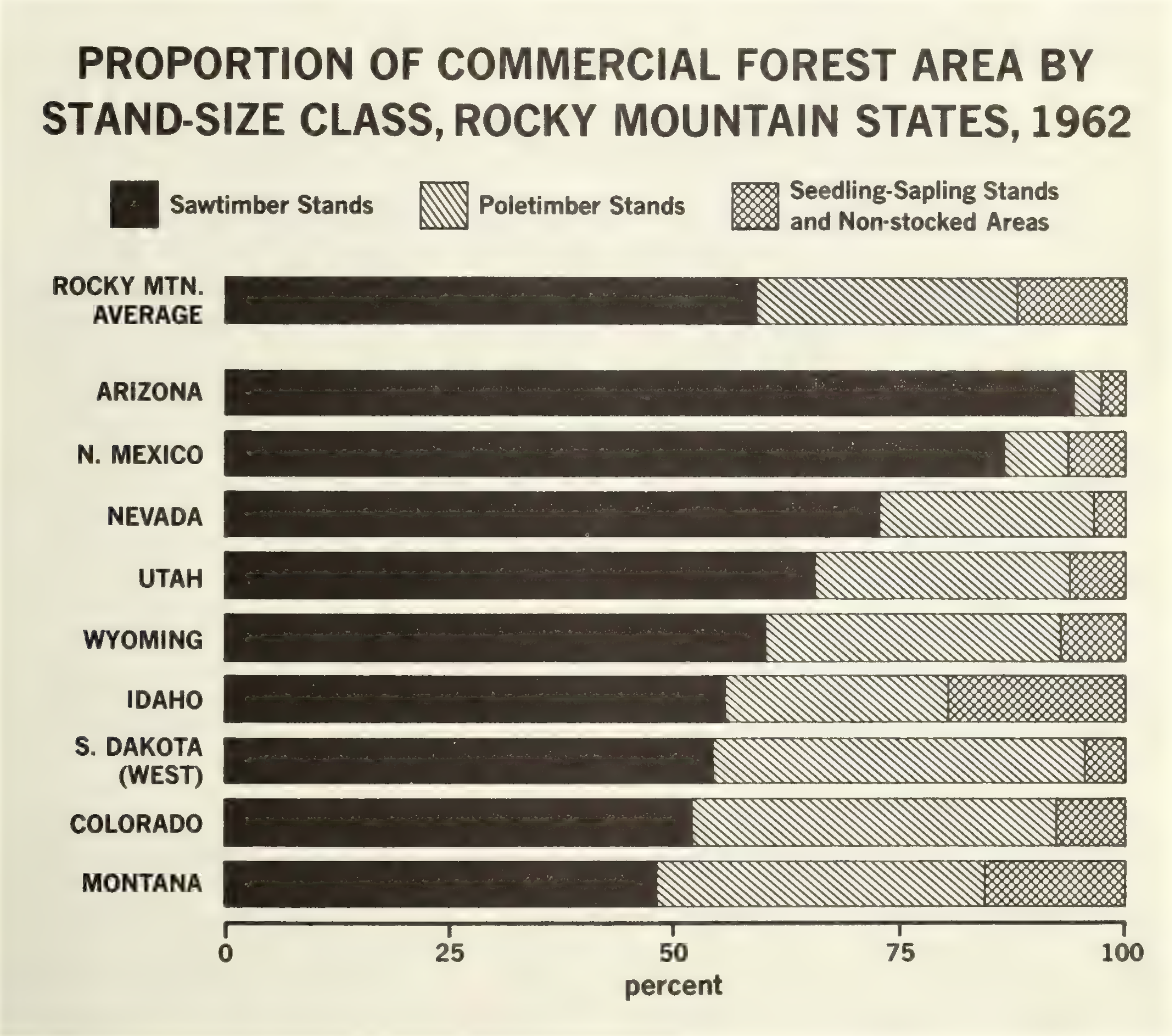

Figure 16

The area of seedling-sapling stands is small in the Rockies; it comprises only 4 million acres or 7 percent of the commercial forest land. The bulk (73 percent) of these stands is in Idaho and Montana. Seventy-five percent of the seedling-sapling stands in the Mountain States is in public ownership.

Nonstocked areas constitute only 5 percent (3.6 million acres) of the Mountain States' commercial forest area, most of which (2.7 million acres) is in Idaho and Montana. Public agencies administer 65 percent of the nonstocked commercial forest land in the Rockies, but in Colorado, Montana, and Nevada most of these lands are privately owned.

Areas of ponderosa pine and Douglas-fir types lead in the Rocky Mountains

The ponderosa pine type grows on 19.4 million acres in the Rockies and is found in every Mountain State. (Fir-spruce is the only other commercial type that is classed in every Mountain State.) This forest type constitutes 29 percent of the commercial forest area in the Mountain States, which is more than any other type. The commercial forests in western South Dakota and Arizona are especially dominated by this type. The ponderosa pine type constitutes 98 percent of the commercial forest area in western South Dakota and 92 percent in Arizona.

The 13.3 million acres classed as Douglas-fir type represent 20 percent of the Mountain States' commercial forest area. The bulk (70 percent) of this type grows in Idaho and Montana.

Lodgepole pine type grows on nearly 20 percent (12.8 million acres) of the Mountain States' commercial forest area. The northern Mountain States contain almost four-fifths of this area, most of which (5.4 million acres) is in Montana. This forest type accounts for 31 percent of Montana's commercial forest area. No areas are classed as lodgepole pine type in western South Dakota or in the Southwest.

The fir-spruce type ranks fourth largest in the Rockies, growing on 8.9 million acres. Somewhat more of this type is found in the southern than in the northern Mountain States. Colorado contains the largest share of this type with 3.4 million acres.

The larch type, which accounts for only 4 percent of the Mountain States' commercial forest area, is found only in western Montana and northern Idaho. Its total area is 2.7 million acres, and 1.9 million acres of this is in Montana.

The white pine type grows on 2.4 million acres in the Rocky Mountains. The principal concentration of this type is in northern Idaho, although it extends into western Montana and slightly into western Nevada.

Colorado has largest area of hardwood types

Aspen is the principal hardwood type and occurs for the most part in the southern Rocky Mountain area. Of the 5.9 million acres of hardwoods in the Mountain States, 4.6 million acres are in this area. In the Mountain States, Colorado has the largest area of hardwoods (2.9 million acres), and in Utah these types account for the largest proportion of the commercial forest (32 percent).

Timber Volumes

Idaho and Montana contain most of the timber volume in the Mountain States

Nearly two-thirds of the 97.8 billion cubic feet of sound, live trees in the Rocky Mountain States grow in northern States. Idaho and Montana together account for 55 percent of the Mountain States' total.

Practically all of the volume in the Rockies is in softwood trees. In the northern Rocky Mountains, softwoods make up 99 percent of the volume, compared with 88 percent in the southern Rockies. In Utah, hardwoods (mostly aspen) account for 23 percent of the cubic-foot volume--the largest proportion found in the Mountain States.

Idaho and Montana have the largest volumes per acre of sound, live trees of pole size and larger in sawtimber stands:

State[1]	Average volume per acre (Cubic feet)
Idaho	2,397
Montana	2,292
Colorado	1,978
Wyoming	1,944
Utah	1,774
Arizona	1,589
New Mexico	1,159
South Dakota (western)	1,020
Average	1,953

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[1] Data for Nevada are not available.

The bulk of the volume is publicly owned

Eighty-three percent of the cubic-foot volume of timber in the Mountain States is publicly owned. Of this, almost 90 percent is on National Forests.

Arizona's 98 percent is the highest proportion of publicly owned cubic-foot volume among the Mountain States. (Only Alaska has a higher proportion among all States.) In contrast, three-fourths of the volume in Nevada is privately owned. The 6.6 billion cubic feet in private ownership in Montana is the largest such volume in the Mountain States, although it represents only 25 percent of that State's total volume.

Largest volumes in Douglas-fir and ponderosa pine

Douglas-fir (18.6 billion cubic feet) and ponderosa pine (17.9 billion cubic feet) together account for 37 percent of the Mountain States' total volume of timber. Three-fourths of the Douglas-fir volume is in Idaho and Montana. The ponderosa pine volume is slightly less than that of Douglas-fir, despite the fact that there are 6.1 million acres more in the ponderosa pine type than in the Douglas-fir type. More ponderosa pine volume is found in the southern Mountain States than in northern Mountain States. The Southwest alone contains 9.0 billion cubic feet--more than one-half the Mountain States' total for this species.

The volume of lodgepole pine is 16.9 billion cubic feet or 17 percent of the Mountain States' total volume of all species. Three-fourths of the lodgepole pine volume is in the northern Rocky Mountains--mostly in Montana.

Engelmann spruce volume is 14.2 billion cubic feet or 15 percent of the Rocky Mountain volume for all species. The southern Rocky Mountain States contain somewhat more spruce volume than those in the north; the bulk of this (6.4 billion cubic feet) is found in Colorado.

True firs make up 12.6 billion cubic feet or 13 percent of the volume for all species in the Rockies. Two thirds of this volume is in the northern Rocky Mountains.

Other softwood species--principally western larch, western white pine, western hemlock, and western redcedar--provide 12.3 billion cubic feet or 13 percent of the total volume in the Mountain States. Practically all of this volume is in Idaho and Montana.

Hardwoods account for 5.2 billion cubic feet in the Rockies, which is 5 percent of the total volume. The southern Rocky Mountains grow the bulk (83 percent) and Colorado has the largest share (2.4 billion cubic feet).

Much of the volume is in small diameter trees

Nearly 75 percent of the cubic-foot volume in the Rocky Mountains is in trees less than 19 inches in diameter at breast height (d.b.h.). This compares with 61 percent of the sawtimber volume. Only 6 percent of the cubic-foot volume and 10 percent of the sawtimber volume are in trees over 30 inches d.b.h. There is little difference in proportion of sawtimber volume in larger diameters between the northern and southern Rocky Mountain States.

Growth and Cut

Growth information of limited value in Mountain States

Current growth rates are not particularly useful criteria for comparing Mountain States with each other or the Rocky Mountain region with other regions of the country. The high level of mortality associated with the large areas of old-growth timber in the Rocky Mountains results in comparatively low net growth rates (because mortality is subtracted from gross growth to obtain net growth). A relatively high current growth rate for an area usually indicates that old-growth sawtimber has been liquidated more rapidly than elsewhere and has been replaced by vigorous, young stands. A comparison of current growth rates among Mountain States, then, probably is most useful in gaging the speed of removal of a State's overmature stands. Until wild stands have been converted to managed stands throughout the Rocky Mountains, current growth rates will not even roughly reflect the inherent growth capacity in each State.

Net growth rate of sound, live trees highest in western South Dakota

In western South Dakota the net growth of 21 million cubic feet in 1962 was 2.11 percent of the State's inventory of growing stock. This is the highest rate among the Rocky Mountain States, and is more than double the Mountain States' average of 0.97 percent. Arizona's 1962 growth of 90 million cubic feet was 1.48 percent of inventory--the second highest growth rate in the Mountain States. Logging has been widespread in both western South Dakota and Arizona over the years. This probably accounts for their current relatively high net growth rates. This logging was possible because of relatively accessible timberlands and active markets for mine timbers, lumber, and other products; it served to remove high risk trees before they died. Mortality rates were lowered and growth rates were raised. The net effect was to alter stand structure by replacing many decadent, slow-growing trees with thrifty, young growth.

Early logging also occurred in Idaho, Montana, and elsewhere, but was not nearly as widespread in relation to the total area of each State. Consequently, current growth rates for these States as a whole do not reflect this early cutting nearly as much as those for Arizona and South Dakota.

The 1962 data show Idaho (283 million cubic feet) and Montana (198 million cubic feet) as the Mountain States with the greatest volumes of growth. Respective net growth rates were 1.07 percent and 0.74 percent of inventory.

Cutting rate highest in western South Dakota

The 12 million cubic feet of sound, live trees harvested in western South Dakota during 1962 represented 1.20 percent of the inventory in that State. This is the highest rate of the Mountain States (average 0.70 percent). Cutting rates for northern Mountain States averaged 0.85 percent of growing stock inventory. The southern Rocky Mountain States averaged much lower (0.43 percent), and Colorado (0.21 percent) and Utah (0.22 percent) had the lowest rates.

The Mountain States' average cutting rate for sawtimber is 0.97 percent of the sawtimber inventory. Western South Dakota (1.55 percent) and Arizona (1.50 percent) have the highest rates, and Colorado and Utah, each with 0.30 percent, have the lowest rates.

Growing stock and sawtimber cutting rates are further illustrated in figure 17.

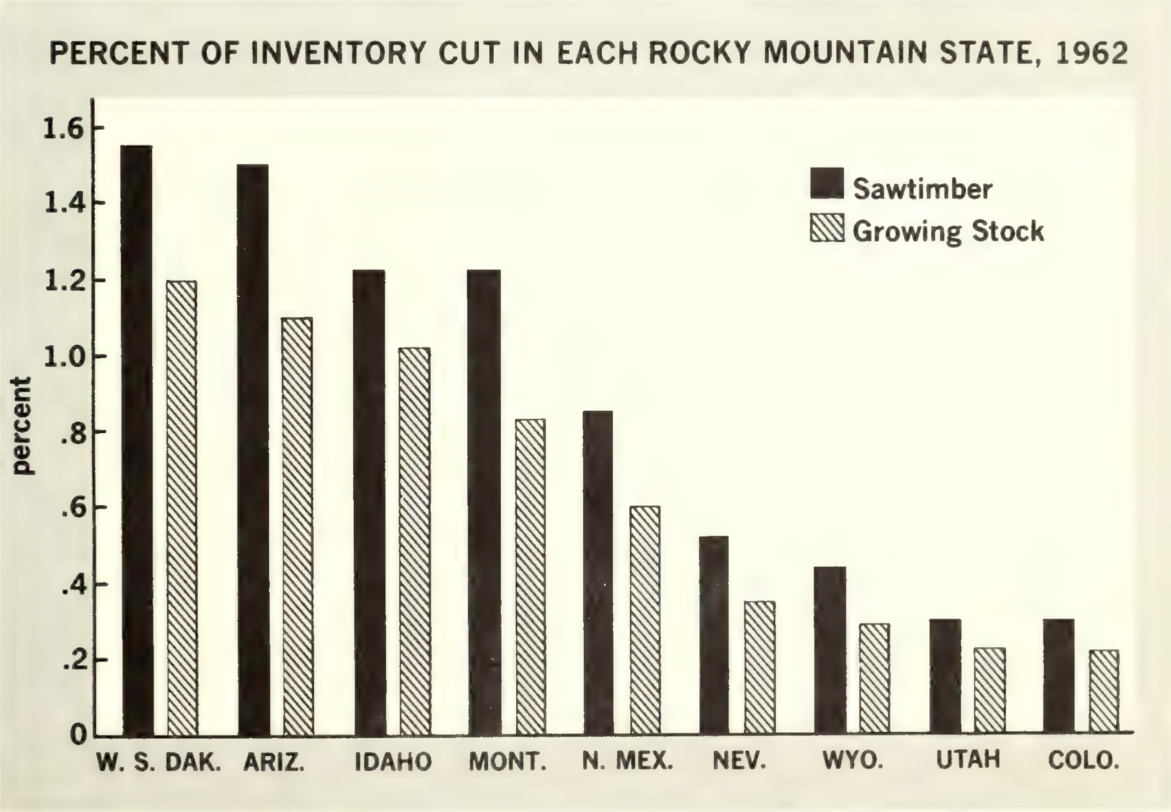


Figure 17

TIMBER INDUSTRIES

Distribution

Timber industry capacity greatest in northern Idaho and western Montana

The distribution of the principal wood-using plants in relation to the occurrence of commercial forest land in the Rocky Mountain States is shown on one of the two foldout maps. Sawmills, plywood plants, and pulpmills are noticeably concentrated in northern Idaho and western Montana, but western South Dakota and Colorado also have above-average densities in sawmills. Nearly 47 percent of all Mountain States' sawmills is in Idaho and Montana, and 23 percent is in Colorado and western South Dakota.

Eleven of the 12 plywood and veneer plants operating in the Mountain States in 1965 were located in Idaho and Montana. Five of these plants were in Idaho, six in Montana, and one in Colorado. By 1965, four pulpmills were also in operation--one each in Idaho and Montana, and two in Arizona.

The Mountain States' only particle board plant is in northern Idaho, but about 50 pole and post yards are distributed throughout the region. About a dozen shingle and shake mills (most of which are in Idaho) and an equal number of plants producing house logs were operating in 1962. Five charcoal producers are scattered from Montana to New Mexico, but the seven excelsior plants are located in only three States--Arizona, Colorado, and Utah. Most of the specialty plants, producing items such as aspen panel board products, cedar fence pickets, and industrial gum (arabinogalactan from larch), are located in Idaho and Montana.

Production

70 percent of timber products made in Idaho and Montana

Idaho and Montana have held a clear lead in the output of roundwood products ever since the first logging in the Mountain States. The white pine and ponderosa pine stands of these two States attracted substantial industrial development around 1900. This industrial capacity has continued and grown, although other species have since moved to leading positions, at least in point of volume consumed. In the latest year of record, 1962, the relative standing of the several Mountain States was as follows for the output of all roundwood products:

State	Roundwood products	
	(M cu. ft.)	(Percent)
Idaho	249,231	38.4
Montana	207,289	31.9
Arizona	65,529	10.1
New Mexico	46,259	7.1
Colorado	36,433	5.6
Wyoming	20,771	3.2
Utah	12,005	1.9
South Dakota (west)	11,235	1.7
Nevada	846	.1
Total	649,598	100.0

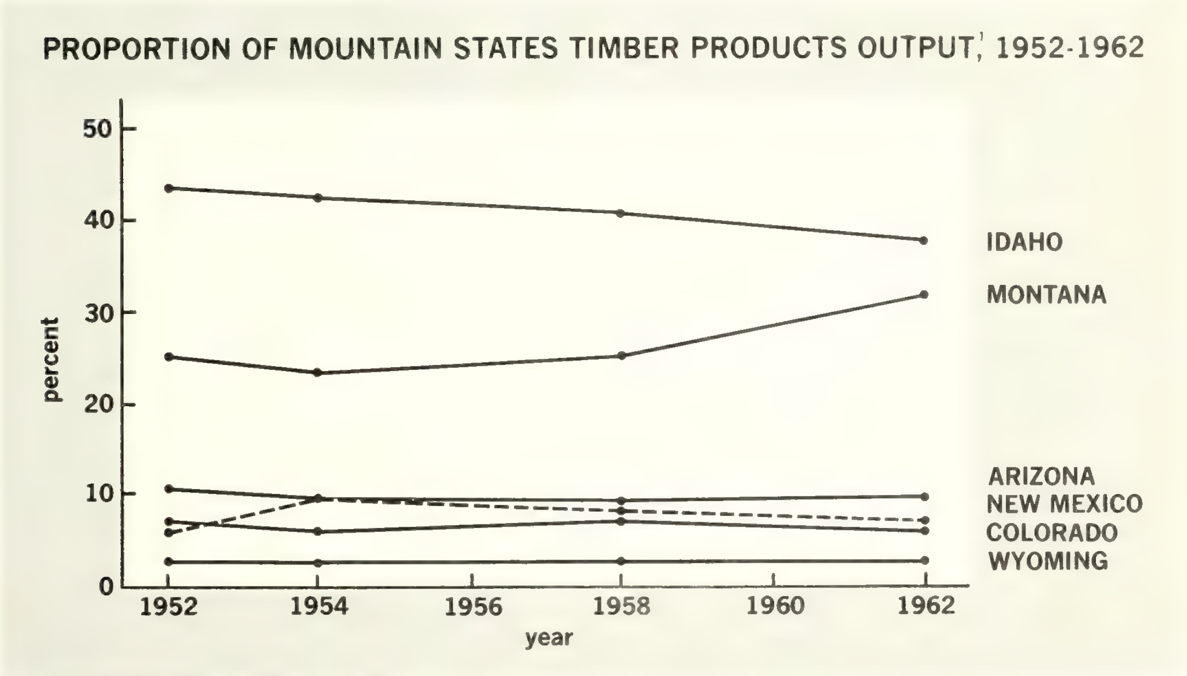
Since 1952 there have been few changes in the relative positions of the nine States in products output, but Montana's share of the total appears to be increasing rapidly while Idaho's share shows some tendency to decline (figure 18). New Mexico traded places with Colorado between 1952 and 1954 and has since maintained fourth place following Arizona.

48 percent of roundwood products from ponderosa pine and Douglas-fir

Ponderosa pine is the most important species for roundwood products in the Mountain States, but Douglas-fir is not far behind (figure 20). Out of an all-species total of 650 million cubic feet, 171 million cubic feet of ponderosa pine and 140 million cubic feet of Douglas-fir were made into roundwood products in 1962. Ponderosa pine is the dominant species in Arizona, New Mexico, western South Dakota, and Nevada, but large amounts are also cut in Idaho and Montana. Douglas-fir is the leader in Idaho and Montana--90 percent of all the Douglas-fir cut for timber products in the Mountain States comes from these two States. The true firs and western white pine are also important in Idaho; western larch is the second most important species in Montana. Wyoming's top species is lodgepole pine, and Colorado's is Engelmann spruce.

57 percent of timber products come from National Forest lands

The National Forests were the prime source of timber products in eight of the nine Mountain States, and accounted for 57 percent of all roundwood products in 1962. Forest industry lands led all other ownership classes in Nevada, and for the Mountain States as a whole, this ownership class ranked second in output and was particularly important in Idaho and Montana.


PROPORTION OF MOUNTAIN STATES TIMBER PRODUCTS OUTPUT,[1] 1952-1962

[1] Utah, Nevada, and Western South Dakota not plotted because of low percentage values.

Figure 18

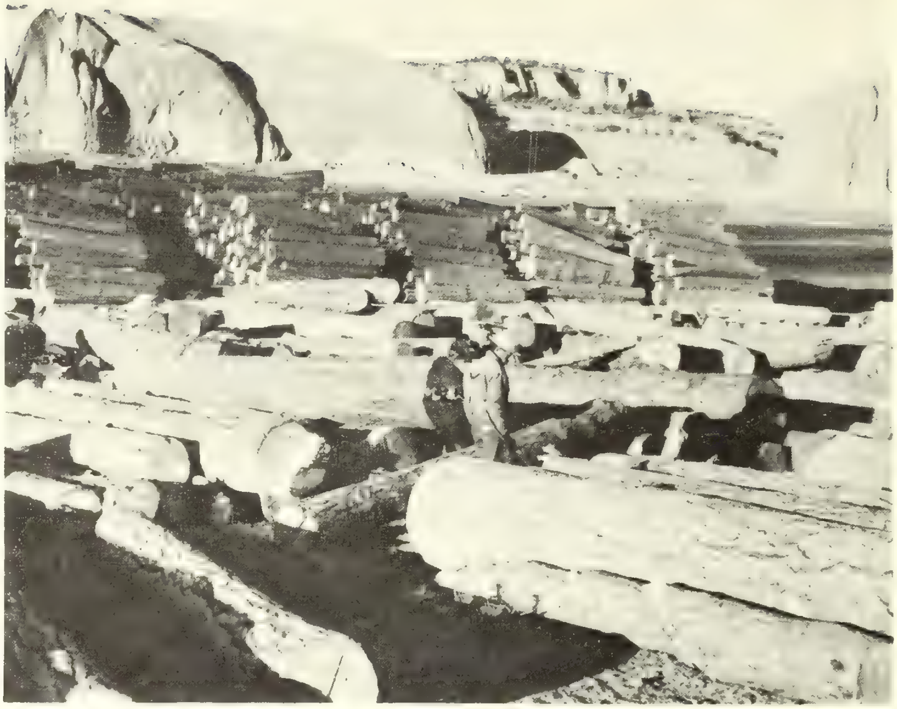


Figure 19.--Part of log deck at Navajo Forest Products Industries sawmill at Navajo, New Mexico. Although most of the timber harvested in the Mountain States is still sawn into lumber (as these ponderosa pine logs will be) the pulp and veneer industries are important users of wood in parts of the Rockies.

Production by general ownership classes in 1962 is shown in the following tabulation:

Ownership class	Timber products output (Million cubic feet)
National Forests	369
Other public	73
Forest industry	114
Other private	94
Total	650

Saw logs are dominant timber product

Saw logs for lumber have always been the principal roundwood product in the Mountain States. In 1962 a total of 3,820 million board feet was produced. This constituted 88 percent of all timber products and dominated the roundwood output of all nine States. Within States, the percentage of total output in saw logs ranged from 48 (Nevada) to 94 (in both Idaho and Wyoming), based on cubic-foot volumes.

Since saw logs are the predominant product, the foldout map showing saw log output by counties in 1962 provides an index to timber producing localities as well as a means of estimating the relative importance of these localities. Lincoln, Flathead, and Missoula Counties in Montana, and Clearwater and Idaho Counties in Idaho were the leading producers in the northern Rockies; but large volumes were also produced in Sanders County, Montana, and Bonner, Kootenai, and Shoshone Counties in Idaho. In the southern Mountain States, Coconino County in Arizona led in saw log production, followed by Apache County in Arizona, and Catron County in New Mexico.

Almost 54 percent (by weight) of the shipments of lumber and dimension stock from Mountain States[9] was sent to other Mountain States in 1963 (67). About 12 percent was exported to East North Central States (Illinois, Indiana, Michigan, Ohio, and Wisconsin), and 10 percent was shipped to both the Pacific Coast States (Washington, Oregon, California, Alaska, and Hawaii) and to the West North Central States (Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, and South Dakota).

Nearly one-third (by weight) of the imports of lumber and dimension stock into Mountain States during 1963 came from Pacific Coast States.

Sixty-two percent of the 24 million tons of shipments of lumber and dimension stock in the entire West was transported by rail during 1963; 32 percent was hauled by trucks. The Pacific Coast States are included in these data, but proportions for Mountain States alone probably are similar.

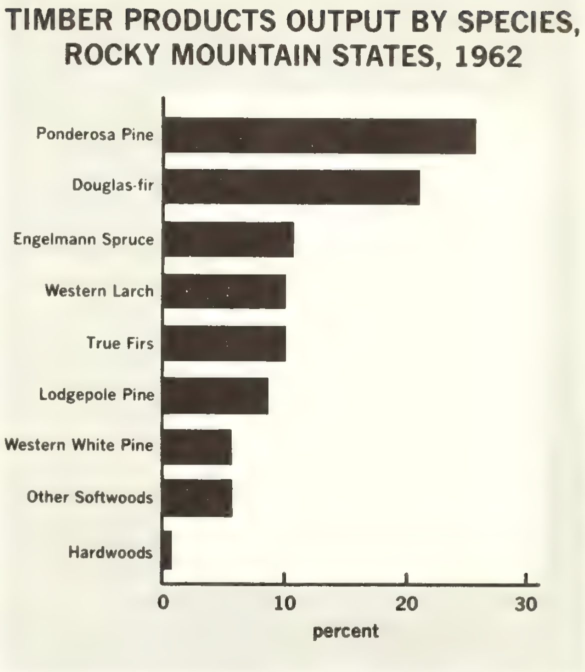


Figure 20

Round pulpwood second most important timber product

Although the volume involved is not great compared to that of saw logs, the 242,000 cords of round pulpwood produced in 1962 ranked this as the second most important single roundwood product in the Mountain States. Arizona, Idaho, Montana, and western South Dakota were the principal producing States, and smaller amounts were cut in Wyoming and Colorado.

Veneer logs important product in Montana and Idaho

Veneer logs were produced only in Montana and Idaho in 1962, but the volume handled (130 million board feet) was sufficient to place this product in third place in the Mountain States. Eighty-five percent of the veneer logs was produced in Montana and the remainder was produced in Idaho.

Posts, fuelwood, and miscellaneous farm timbers as a group constituted 4 percent of the roundwood output. A total of 28 million cubic feet was produced in 1962; New Mexico and Arizona were the top producing States. More than half of the 1962 output of commercial poles (5 million cubic feet) was produced in Idaho, and Colorado produced 45 percent of the round mine timbers and 44 percent of the miscellaneous industrial wood.

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[9] In the Bureau of the Census data used for this analysis, the Mountain States did not include western South Dakota.

Trends

As pointed out earlier, the Mountain States exhibited the strongest upward trend of any section of the country in output of all timber products from 1952 to 1962. Production in 1962 (650 million cubic feet) was 44 percent more than in 1952 (452 million cubic feet). For the same period the United States as a whole showed a decline of 7 percent.

General production trends are upward but vary in strength between States

All Rocky Mountain States show substantial increases in roundwood production in 1962 as compared with 1952, but data for the intermediate years, 1954 and 1958, show that increases in some States followed a more consistently upward course than others. Montana exhibited the strongest and most consistent upward trend (fig. 21); the 1962 output was 77 percent more than that of 1952. Relatively steady upward trends occurred in Wyoming, Idaho, and Arizona. Although trends in other States were generally upward and were especially strong in Utah and Nevada (combined) and in New Mexico, marked fluctuations occur from year to year.

Principal increases were in saw log production

Saw log production in all Mountain States (with minor exceptions in Wyoming and western South Dakota) shows a stronger upward trend (and in most States a more consistent one) than is shown by all roundwood products combined. Saw log production increases were evidently the principal factor in the remarkable gains made from 1952 to 1962 in total roundwood output.

Because of the continuity of the record, Census Bureau lumber production data provide a further means for appraising the course of saw log production within States. These data show that the largest contributors to the output of saw logs, and thus the principals in creating and maintaining the upward movement, were Idaho and Montana. However, similar trends appear in most other Mountain States (fig. 22).

Accompanying this growth there has been a definite tendency for active sawmills to decrease in number, but increase in average size. This tendency is observable throughout the Mountain States (table 3).

Table 3.--Changes in numbers of active sawmills and lumber production per mill, 1962, from previous year of record[1]

State	Base year	Change: Number of mills	Change: M bd. ft. per mill
Idaho	1956	-118	+2,681
Montana	1956	-124	+2,169
Wyoming	1957	-31	+339
Arizona	1960	-10	+2,963
Colorado	1957	-104	+538
New Mexico	1960	-32	+935
Utah and Nevada	1960	-24	+687

[1] Western South Dakota not shown because no data are available for a previous year.

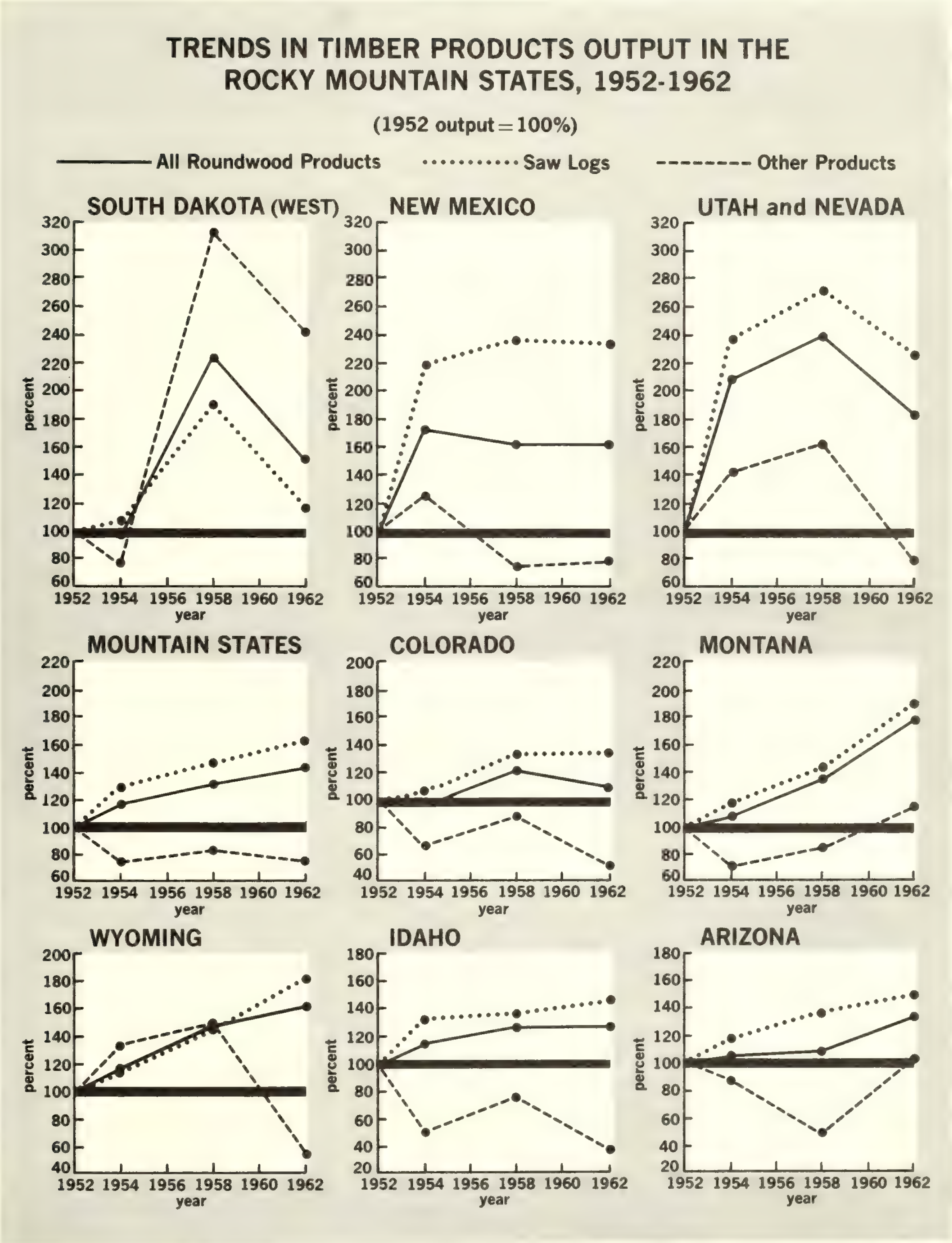
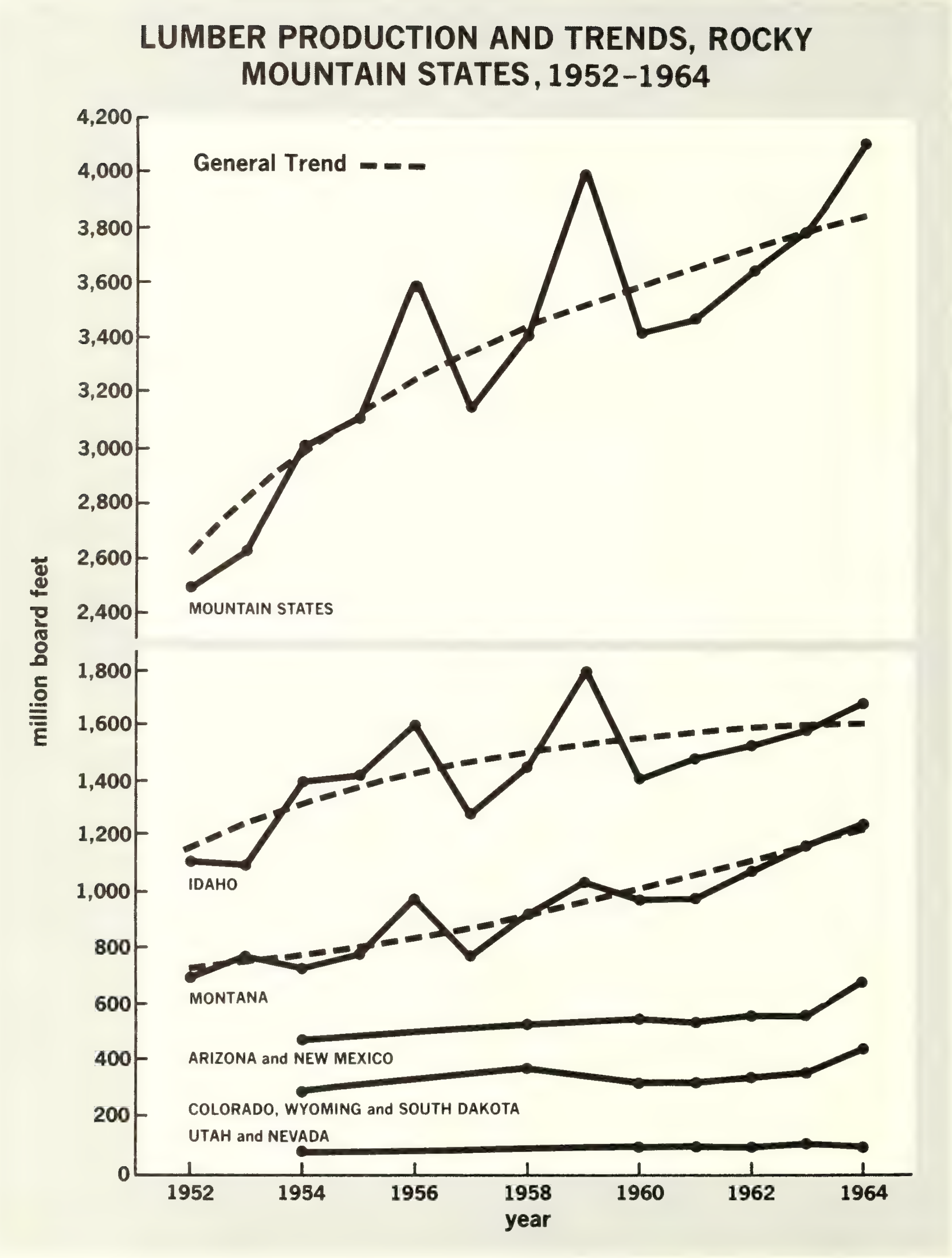

TRENDS IN TIMBER PRODUCTS OUTPUT IN THE ROCKY MOUNTAIN STATES, 1952-1962
(1952 output = 100%)
All Roundwood Products
Saw Logs
Other Products
SOUTH DAKOTA (WEST)
NEW MEXICO
UTAH and NEVADA
MOUNTAIN STATES
COLORADO
MONTANA
WYOMING
IDAHO
ARIZONA
percent
year
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
1952
1954
1956
1958
1960
1962

Figure 21



LUMBER PRODUCTION AND TRENDS, ROCKY MOUNTAIN STATES, 1952-1964

Figure 22

Other products show variety of trends

Products other than saw logs show more erratic trends between 1952 and 1962. These "other products" include veneer logs, round pulpwood, and a variety of miscellaneous roundwood products.[10] The general trend of these for all Mountain States combined shows a decline from 1952 to 1954, followed by a leveling off at about 80 percent of the 1952 output (fig. 21).

Among Mountain States, downward tendencies are most marked in Idaho, Colorado, and New Mexico. In Idaho, the decline occurred principally in the miscellaneous products, which by 1962 amounted only to 24 percent of the 1952 output. However, a decrease in round pulpwood production to 53 percent of 1952 output contributed to the decline and helped to cancel gains made in veneer log production. Idaho veneer log production in 1962 was more than twice the 1952 level. In Colorado and New Mexico the decline was also principally in miscellaneous products, but was additionally influenced in Colorado by a decline in round pulpwood production to 30 percent of its 1952 figure.

Arizona's downtrend in products other than saw logs from 1952 to 1958 was abruptly reversed with the start of round pulpwood production around 1958. Although by 1958 miscellaneous products had fallen to 48 percent of their 1952 level, round pulpwood production brought the combined output back up so strongly that by 1962, output was 1 percent above the 1952 figure.

In Montana, the trend for products other than saw logs was downward from 1952 to 1954. Since 1954, this trend has turned strongly upward, which is in contrast to trends in most Mountain States. By 1962, output was 14 percent higher than in 1952. It is noteworthy that veneer log production increases alone brought about this growth by overcompensating for severe declines in round pulpwood and miscellaneous wood products outputs.

Utah and Nevada (combined) and Wyoming showed strong upward trends for products other than saw logs for much of the 1952-62 period, but fell off sharply after 1958. In Wyoming, strong gains in round pulpwood production (1962 output was nearly 6½ times that of 1952) were insufficient to overcome declines in other products; therefore, 1962 production, other than saw logs, was down to 54 percent of the 1952 level. Utah and Nevada's combined output of miscellaneous products in 1962 was down to 76 percent of the 1952 figure.

For the same period, western South Dakota exhibited the most marked upward trend in products other than saw logs, although here, too, a tendency to decline toward the end of the period is indicated. Strong increases in round pulpwood production throughout the period were accompanied by large increases in other products until about 1958, when declines in these other products caused a downturn. Even so, 1962 output was nearly 2½ times that of 1952.

Large gains in plywood and pulp industries

In passing, it has been briefly pointed out that certain industries, particularly plywood and pulp manufacturing, have undergone some rather remarkable changes since 1952. In all the Mountain States, only two plywood plants (one each in Idaho and Montana) and one veneer plant[11] (in Idaho) were operating in 1952. By 1962, seven plants (two in Idaho, five in Montana) were in operation and

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[10] Includes products such as commercial poles, house logs, converter poles, shingle logs and bolts, excelsior bolts, match splint logs, charcoal wood, round mine timbers, posts, fuelwood, and miscellaneous farm timbers. Output trends for single products among these may differ from the trend of the entire group.

[11] A container veneer plant in southern Idaho which went out of business about 1954. A veneer plant started up in northern Idaho about 1956 and has been in continuous operation since.

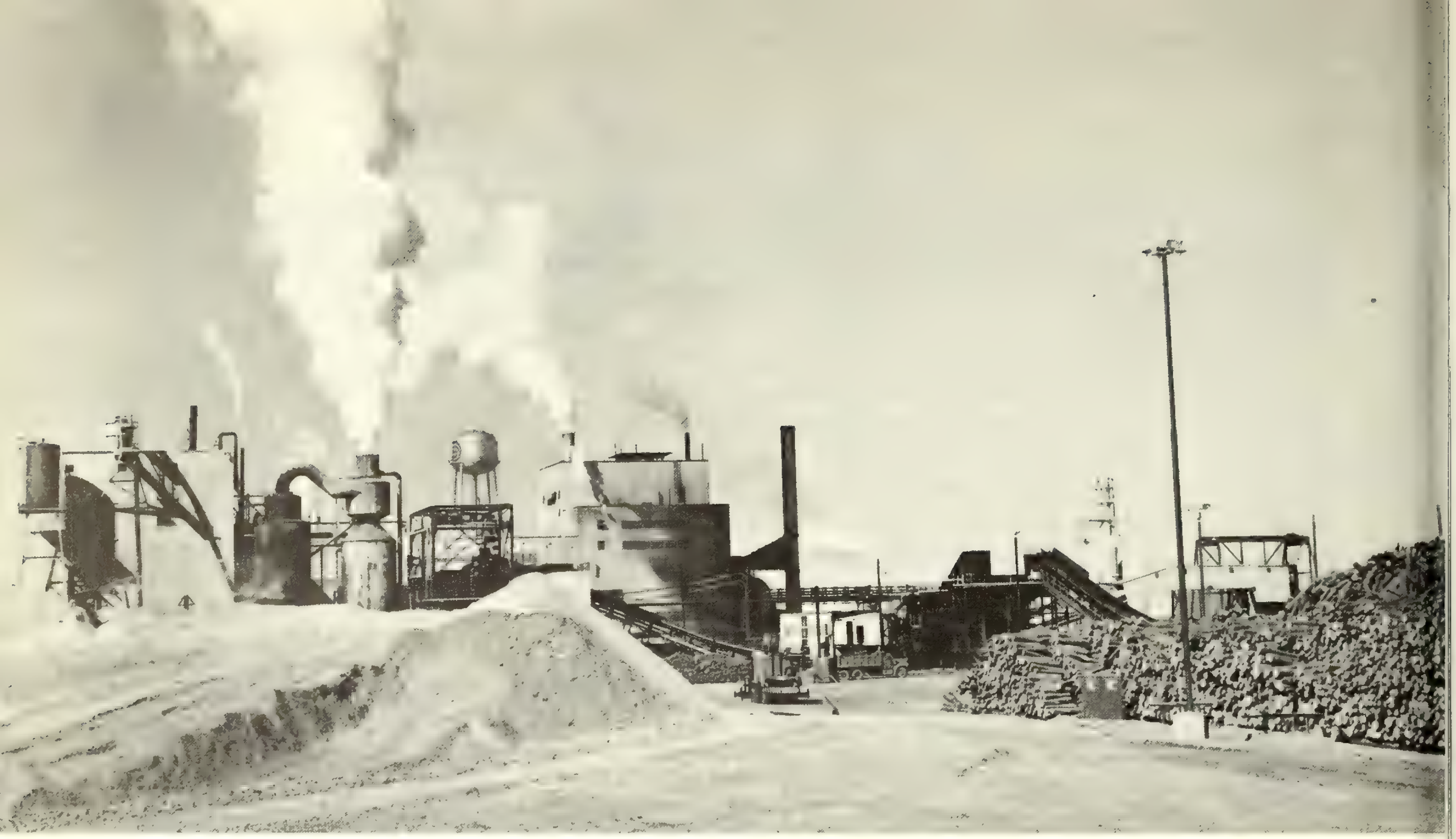

Figure 23.--The Southwest Forest Industries, Inc., pulpmill near Snowflake, Arizona, uses underground water entirely in the manufacturing process. This mill produces about 165,000 tons of Kraft linerboard and newsprint per year using round pulpwood and chipped sawmill residues (foreground).

plywood production was estimated to be 12 times that of 1952. Four more plants went into operation between 1962 and 1965. Two of these are in Idaho, one in Montana, and one in Colorado. Plywood production of all 12 plants in 1965 was estimated to be about 36 times the output in 1952. Installed plant capacity, as of 1965, totals 1,005 million square feet annually, 3/8-inch basis (41).

Pulp production capacity in the Mountain States is limited to one mill in Idaho, one in Montana, and two in Arizona. One of the Arizona mills began production in 1965 on the site of a groundwood mill that closed after operating for a short time about 1956-57. The other mill in Arizona started producing in 1961. Its use of underground water is particularly significant (fig. 23). The successful operation of this mill has done much to dispel the belief that surface water supplies set rather rigid limits to the pulpmill capacity that can be supported in the Mountain States. Installed pulpmill capacity in the Mountain States in 1965 was nearly 1,900 tons per day, or nine times the capacity existing in 1952.

However, these increases cannot be taken to mean that round pulpwood consumption went up correspondingly. The increasing use of chipped sawmill residues for pulp production has had a definite effect on the rate of increase in output of round pulpwood. This is pointed up by comparing the Mountain States wood pulp production, which in 1962 was nearly eight times the output in 1952, with round pulpwood production, which was only 10 percent higher in 1962 than in 1952.

Although the timber industries of the Rocky Mountain States are still oriented strongly toward lumber production, and saw logs are by far the principal roundwood product, the rapid changes now taking place in the plywood and pulp industries presage more and probably faster changes to come.

ECONOMIC COMPARISONS

Lumber and wood products manufacturing industries[12] are important contributors to the economy of the Rocky Mountain area--especially in the northern Mountain States. Following is a short discussion of some of the economic values generated by these timber-based industries.

Idaho and Montana account for two-thirds of timber-based jobs in Rockies

Nearly 30,000 persons were employed in 1963 in lumber and wood products manufacturing industries in the Rocky Mountain States. This is 10 percent of all persons employed by all manufacturing industries in that area. In 1963, employment in timber industries was 9 percent greater than in 1958. Almost 21,000 of the timber industry employees were in the northern Mountain States--19,000 in Idaho and Montana. Lumber and wood products manufacturers accounted for 29 percent of the total employees of manufacturing industries in northern Mountain States, compared with only 4 percent in the southern Mountain States. In Idaho and Montana these figures were 34 and 41 percent, respectively. The share of the manufacturing work force provided by timber-based industries was 2 percent in Utah and 3 percent in Colorado.

Almost 27,000 of the above 30,000 employees were production workers, most of whom were employed by sawmills and planing mills. Foresters and others engaged in timber management activities are not included as production workers.

Timber-based industries in the Mountain States have a payroll of $140 million

The $140 million that lumber and wood products industries paid to their employees in 1963 is a 21 percent gain over the 1958 figure, and represents 8 percent of the total payroll of all manufacturers in the Rocky Mountains. Just as most of the employees are in northern Mountain States, so is most of the payroll--almost three-fourths of it. Idaho and Montana together account for more than two-thirds of the Mountain States timber-based payroll.

Value added by manufacture for timber-based industries was $232 million in 1963

Value added by manufacture--the difference between the cost of goods purchased by an enterprise and the value of the product it sells--is an economic yardstick useful in measuring the dollar-generating ability of an industry. For all lumber and wood products industries in the Rocky Mountains, value added by manufacture (in harvesting and processing timber) amounted to $232 million during 1963. This was 36 percent greater than the $170 million added in 1958. It was also only 6 percent of the total value added by all manufacturers in 1963. When this 6-percent figure is compared with the previously mentioned facts that timber-based industries accounted for 10 percent of the number of employees and 8 percent of the total payroll of all manufacturers in the Rocky Mountains, it is clear that "value added" lags behind. Apparently lumber and wood products industries do not add as much value as the average manufacturing industry in the Mountain States does.

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[12] The U.S. Bureau of the Census provides certain economic data for Standard Industrial Classification (SIC) Code 24, lumber and wood products manufacturing industries. This classification includes logging operations, sawmills, planing mills, millwork plants (includes veneer and plywood plants), wood preserving concerns, and other primary wood conversion industries. Similar information has not been published for the pulp and paper manufacturing industry (SIC Code 26) in the Mountain States, although this is an important wood-using industry in Idaho, Montana, and Arizona.

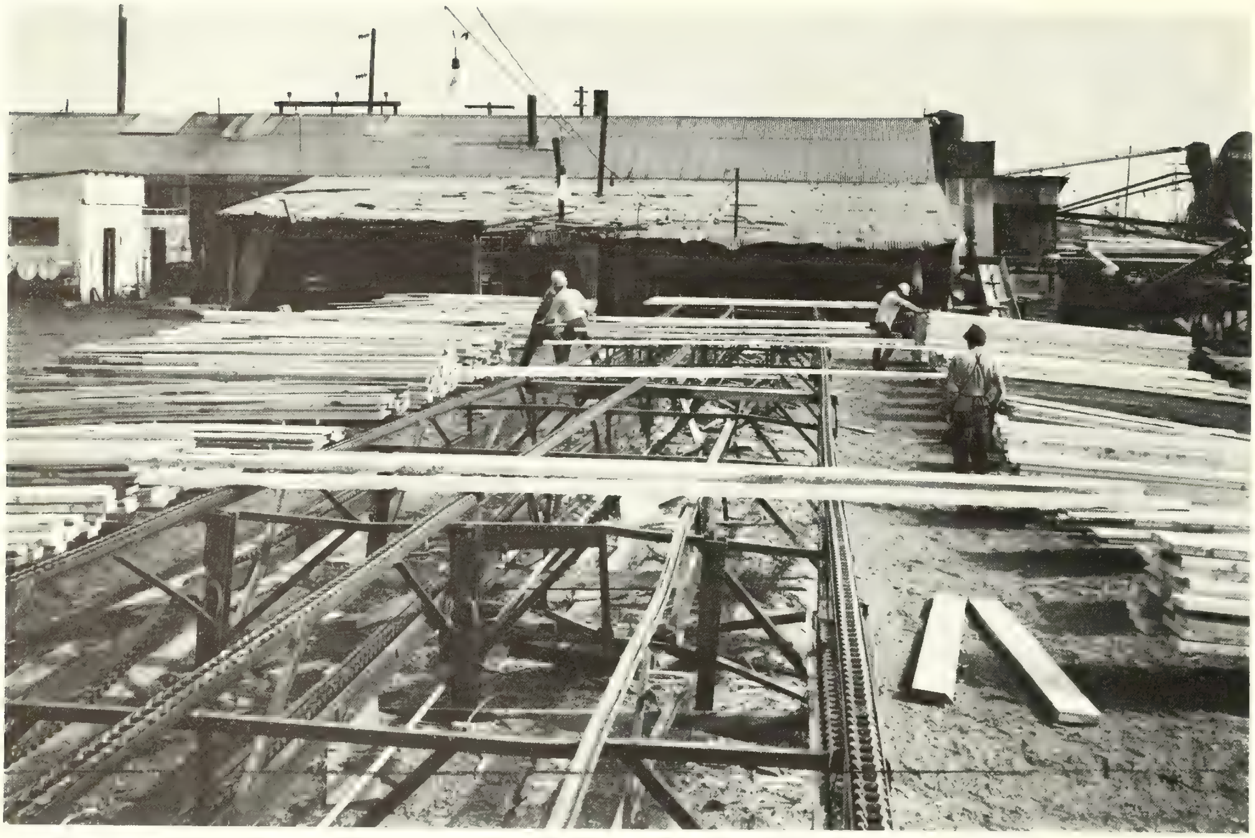

Figure 24.--Crofts-Pearson Industries sawmill at Panguitch, Utah. This mill produces about 120,000 board feet of lumber per day, which easily makes it the largest mill in the State. Because mills in Utah are few and generally small, the number of jobs provided by timber-based industries also is small.

In terms of value added by manufacture per employee in the lumber and wood products industries, the Rocky Mountain States average of $7,800 is above the $7,100 average for the United States. Both of these figures are less than two-thirds of the respective averages for all manufacturing industries. Within the Mountain States,[13] the range is from a high of $8,400 per lumber and wood products industries employee in Idaho to a low of $5,500 per employee in Utah.

Idaho and Montana together contribute $157 million in value added, which is two-thirds of the timber-based industry total in the Mountain States. South Dakota[14] accounted for the smallest share of value added ($4.5 million) and was the only Mountain State to have a smaller amount in 1963 than in 1958. Wyoming showed the greatest increase (70 percent) in this 6-year period.

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[13] Nevada was excluded from this comparison because of the small number of persons employed in lumber and wood products industries in that State.

[14] All of the economic data provided by the Bureau of the Census is for the entire State. However, practically all of the lumber and wood products manufacturers are located in western South Dakota.

Capital expenditures in Rocky Mountains reached $30 million in 1963

Capital expenditures on plant and equipment are a useful means of gaging the optimism of businessmen and the confidence they have in the long-term success of the enterprise. In 1963, such expenditures in the Mountain States for lumber and wood products industries totaled nearly $30 million--53 percent more than the $19 million spent in 1958. The 1963 expenditures were 12 percent of the total capital expenditures for all manufacturing industries in the Rocky Mountain States.

Capital expenditures by timber-based industries in Idaho ($12 million) and Montana ($9 million) together accounted for nearly three-fourths of the Rocky Mountain total for these expenditures. All Mountain States showed an increase in the amount of capital expenditures in 1963 over 1958 except Colorado, where there was a decrease of 39 percent.

Other information, as well as data in this report, necessary for projecting future timber use

The most recent data on employment, payrolls, value added by manufacture, and capital expenditures have been discussed here to permit certain comparisons within the Rocky Mountain States. These data, however, have practically no value for estimating or projecting future industrial development in the various States unless they are used along with other information and certain assumptions. Important factors that must be considered are the inventory (amount, size and species of trees, stand conditions, accessibility, etc.), present cut (amount, size and species of trees, etc.), present industrial installation (mill capacities and locations, efficiency, products, diversification, etc.), markets (size and location, stability, etc.), transportation facilities and costs, and other considerations.

The present situation with respect to some of these factors is shown in statistical tables on the following pages and has been discussed earlier. Information on many of the factors must come from special studies before analyses can be made to project future industrial development in the Rocky Mountain States.

Table 4.--LAND AREAS IN THE ROCKY MOUNTAIN STATES, BY MAJOR LAND CLASSES, 1962

State	Total land area[1]	Forest land				Nonforest land
		Total	Commercial	Productive reserved	Unproductive	
	- - - - - - - - - -	- - - - - - - - - -	- - - - - -	Thousand acres	- - - - - - - - - -	- - - - - - - - - -
Idaho	52,933	21,815	15,823	1,867	4,125	31,118
Montana	93,271	22,048	17,300	1,356	3,392	71,223
South Dakota (west)	6,879	1,399	1,311	20	68	5,480
Wyoming	62,343	9,777	4,853	2,580	2,344	52,566
Arizona	72,688	20,598	3,977	353	16,268	52,090
Colorado	66,486	22,583	12,275	465	9,843	43,903
Nevada	70,264	12,036	109	27	11,900	58,228
New Mexico	77,766	18,187	6,269	561	11,357	59,579
Utah	52,697	14,865	3,999	165	10,701	37,832
Total	555,327	143,308	65,916	7,394	69,998[2]	412,019

[1] From U.S. Bureau of the Census, Land and Water Area of the United States, 1960.

[2] Includes 4,710 thousand acres of reserved forest land.

Table 5.--AREA OF COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY OWNERSHIP CLASS, 1962

State	All ownerships	Federal					State	County and municipal	Private
		Total	National Forests	Bureau of Land Management	Indian[1]	Miscel-laneous			
	- - - - - - - -	- - - - - - - -	- - - - - - - -	- - - - - - - -	Thousand acres	- - - - - - - -	- - - - - - - -	- - - - - - - -	- - - - - - - -
Idaho	15,823	11,817	11,310	404	102	1	940	(2/)	3,066
Montana	17,300	11,801	10,578	612	595	16	601	38	4,860
South Dakota (west)	1,311	967	957	6	--	4	62	--	282
Wyoming	4,853	3,883	3,364	395	124	--	111	--	859
Arizona	3,977	3,776	2,630	2	1,144	--	32	2	167
Colorado	12,275	8,907	8,384	415	103	5	190	45	3,133
Nevada	109	32	30	2	--	--	--	--	77
New Mexico	6,269	4,161	3,458	77	617	9	172	--	1,936
Utah	3,999	3,096	2,783	155	158	--	240	--	663
Total	65,916	48,440	43,494	2,068	2,843	35	2,348	85	15,043

[1] Indian Reservation lands are under federal trusteeship and are managed by the Bureau of Indian affairs, even though these lands are private in many respects.

[2] Less than 0.5 thousand acres.

Table 6.--AREA OF COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY STAND-SIZE CLASS, 1962

State	All areas	Sawtimber stands			Poletimber stands	Seedling and sapling stands	Nonstocked areas
		Total	Old growth	Young growth			
	Thousand acres						
Idaho	15,823	8,741	4,666	4,075	3,911	1,598	1,573
Montana	17,300	8,284	3,081	5,203	6,311	1,576	1,129
South Dakota (west)	1,311	708	([1])	708	542	45	16
Wyoming	4,853	2,919	15	2,904	1,588	235	111
Arizona	3,977	3,743	1,957	1,786	128	41	65
Colorado	12,275	6,352	449	5,903	4,990	499	434
Nevada	109	79	41	38	26	1	3
New Mexico	6,269	5,454	2,971	2,483	426	169	220
Utah	3,999	2,629	572	2,057	1,125	218	27
Total	65,916	38,909	13,752	25,157	19,047	4,382	3,578

[1] Less than 0.5 thousand acres.

Table 7.--AREA OF COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY OWNERSHIP GROUP AND STAND-SIZE CLASS, 1962

State	All stands	Public ownership					Private ownership				
		Total	Sawtimber stands	Poletimber stands	Seedling and sapling stands	Nonstocked areas	Total	Sawtimber stands	Poletimber stands	Seedling and sapling stands	Nonstocked areas
	Thousand acres										
Idaho	15,823	12,757	7,223	3,169	1,166	1,199	3,066	1,518	742	432	374
Montana	17,300	12,440	5,924	4,649	1,322	545	4,860	2,360	1,662	254	584
South Dakota (west)	1,311	1,029	609	373	34	13	282	99	169	11	3
Wyoming	4,853	3,994	2,341	1,349	207	97	859	578	239	28	14
Arizona	3,977	3,810	3,607	114	24	65	167	136	14	17	--
Colorado	12,275	9,142	5,071	3,540	362	169	3,133	1,281	1,450	137	265
Nevada	109	32	17	14	1	--	77	62	12	--	3
New Mexico	6,269	4,333	3,783	294	36	220	1,936	1,671	132	133	--
Utah	3,999	3,336	2,236	943	141	16	663	393	182	77	11
Total	65,916	50,873	30,811	14,445	3,293	2,324	15,043	8,098	4,602	1,089	1,254

Table 8.--AREA OF COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY FOREST TYPE, 1962

State	Total all types	Softwood types								Total hardwood types
		Total	Ponderosa pine	Douglas-fir	Lodgepole pine	Fir-spruce	Larch	White pine	Other softwoods	
	Thousand acres									
Idaho	15,823	15,275	2,624	4,798	3,023	1,755	730	2,178	167	548
Montana	17,300	16,901	3,656	4,555	5,357	1,180	1,939	181	33	399
South Dakota (west)	1,311	1,311	1,288	0	--	23	0	0	--	--
Wyoming	4,853	4,508	992	701	1,802	847	0	0	166	345
Arizona	3,977	3,898	3,658	130	0	110	0	0	--	79
Colorado	12,275	9,398	2,347	1,451	2,068	3,393	0	0	139	2,877
Nevada	109	88	55	--	16	16	0	1	--	21
New Mexico	6,269	5,902	4,334	1,000	0	525	0	0	43	367
Utah	3,999	2,717	432	646	563	1,047	0	0	29	1,282
Total	65,916	59,998	19,386	13,281	12,829	8,896	2,669	2,360	577	5,918

Table 9.--VOLUME OF GROWING STOCK, SAWTIMBER, AND POLETIMBER ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, 1962

State	Growing-stock trees			Sawtimber trees			Poletimber trees		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	Million cubic feet								
Idaho	26,514	26,244	270	21,755	21,691	64	4,759	4,553	206
Montana	26,770	26,486	284	20,341	20,158	183	6,429	6,328	101
South Dakota (west)	996	991	5	685	684	1	311	307	4
Wyoming	7,458	7,134	324	5,221	5,127	94	2,237	2,007	230
Arizona	6,091	5,967	124	5,534	5,487	47	557	480	77
Colorado	17,337	14,897	2,440	12,218	11,519	699	5,119	3,378	1,741
Nevada	151	126	25	113	109	4	38	17	21
New Mexico	6,616	6,237	379	5,672	5,446	226	944	791	153
Utah	5,825	4,490	1,335	4,249	3,853	396	1,576	637	939
Total	97,758	92,572	5,186	75,788	74,074	1,714	21,970	18,498	3,472

Table 10.--VOLUME OF GROWING STOCK ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY OWNERSHIP CLASS, 1962

State	All ownerships			National Forest			Other public			Private		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	Million cubic feet											
Idaho	26,514	26,244	270	20,561	20,461	100	2,060	2,001	59	3,893	3,782	111
Montana	26,770	26,486	284	17,906	17,705	201	2,254	2,244	10	6,610	6,537	73
South Dakota (west)	996	991	5	782	782	(1/)	48	47	1	166	162	4
Wyoming	7,458	7,134	324	6,046	5,870	176	579	525	54	833	739	94
Arizona	6,091	5,967	124	4,389	4,345	44	1,556	1,512	44	146	110	36
Colorado	17,337	14,897	2,440	13,796	12,044	1,752	782	650	132	2,759	2,203	556
Nevada	151	126	25	38	17	21	(1/)	(1/)	(1/)	113	109	4
New Mexico	6,616	6,237	379	3,387	3,326	61	1,369	1,341	28	1,860	1,570	290
Utah	5,825	4,490	1,335	4,635	3,687	948	568	438	130	622	365	257
Total	97,758	92,572	5,186	71,540	68,237	3,303	9,216	8,758	458	17,002	15,577	1,425

[1/] Less than 0.5 million cubic feet.

Table 11.--VOLUME OF SAWTIMBER ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY OWNERSHIP CLASS, 1962

State	All ownerships			National Forest			Other public			Private		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
	Million board feet, International ¼-inch log rule											
Idaho	126,801	126,484	317	94,985	94,822	163	11,074	11,021	53	20,742	20,641	101
Montana	112,637	111,799	838	75,479	74,883	596	9,454	9,423	31	27,704	27,493	211
South Dakota (west)	3,430	3,423	7	2,687	2,687	(1/)	178	177	1	565	559	6
Wyoming	28,324	27,939	385	23,871	23,762	109	1,850	1,747	103	2,603	2,430	173
Arizona	26,951	26,692	259	19,153	19,105	48	7,297	7,203	94	501	384	117
Colorado	64,258	60,477	3,781	52,793	50,135	2,658	2,611	2,359	252	8,854	7,983	871
Nevada	572	565	7	87	84	3	2	2	--	483	479	4
New Mexico	28,343	27,110	1,233	14,859	14,678	181	6,243	6,153	90	7,241	6,279	962
Utah	22,341	20,213	2,128	18,260	16,552	1,708	2,121	1,989	132	1,960	1,672	288
Total	413,657	404,702	8,955	302,174	296,708	5,466	40,830	40,074	756	70,653	67,920	2,733

[1/] Less than 0.5 million board feet.

Table 12.--VOLUME OF GROWING STOCK ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY SPECIES, 1962

State	All species	Softwoods											Hardwoods		
		All softwoods	Douglas-fir	Ponderosa pine 1/	Lodgepole pine	Engelmann spruce 2/	True firs 3/	Western larch	Western white pine 4/	Western hemlock	Western red-cedar	Other softwoods 5/	All hardwoods	Cottonwood and aspen	Other hardwoods
	Million cubic feet														
Idaho	26,514	26,244	7,775	3,166	3,775	1,797	4,557	1,362	2,356	581	757	118	270	264	6
Montana	26,770	26,486	6,247	2,481	6,124	2,145	3,253	4,075	315	911	579	356	284	224	60
South Dakota (west)	996	991	0	945	--	46	0	0	0	0	0	--	5	--	5
Wyoming	7,458	7,134	901	696	2,768	1,694	644	0	0	0	0	431	324	324	--
Arizona	6,091	5,967	283	5,204	0	231	210	0	0	0	0	39	124	124	--
Colorado	17,337	14,897	1,590	1,017	3,286	6,404	2,409	0	0	0	0	191	2,440	2,434	6
Nevada	151	126	(6/)	74	7	1	39	0	2	0	0	3	25	14	11
New Mexico	6,616	6,237	942	3,837	0	706	594	0	0	0	0	158	379	379	--
Utah	5,825	4,490	899	434	971	1,217	912	0	0	0	0	57	1,335	1,335	--
Total	97,758	92,572	18,637	17,854	16,931	14,241	12,618	5,437	2,673	1,492	1,336	1,353	5,186	5,098	88

1/ Includes Jeffrey pine.
2/ Includes white and blue spruce.
3/ Includes grand, white, subalpine, corkbark, and California red firs.
4/ Includes sugar pine.
5/ Includes limber and whitebark pine, incense cedar.
6/ Less than 0.5 million cubic feet.

Table 13.--VOLUME OF SAWTIMBER ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY SPECIES, 1962

State	All species	Softwoods											Hardwoods		
		All softwoods	Douglas-fir	Ponderosa pine 1/	Engelmann spruce 2/	True firs 3/	Lodgepole pine	Western larch	Western white pine 4/	Western hemlock	Western red-cedar	Other softwoods 5/	All hardwoods	Cottonwood and aspen	Other hardwoods
	Million board feet, International ¼-inch log rule														
Idaho	126,801	126,484	40,495	18,509	11,177	23,241	5,436	6,892	13,754	3,130	3,494	356	317	317	--
Montana	112,637	111,799	29,193	12,405	11,618	14,287	13,496	21,955	1,605	3,346	2,478	1,416	838	762	76
South Dakota (west)	3,430	3,423	0	3,222	201	0	--	0	0	0	0	--	7	--	7
Wyoming	28,324	27,939	4,215	2,545	8,663	2,187	8,689	0	0	0	0	1,640	385	385	--
Arizona	26,951	26,692	1,476	22,883	1,215	932	0	0	0	0	0	186	259	259	--
Colorado	64,258	60,477	6,481	4,261	30,634	8,917	9,497	0	0	0	0	687	3,781	3,770	11
Nevada	572	565	(6/)	331	3	177	33	0	7	0	0	14	7	4	3
New Mexico	28,343	27,110	5,025	16,188	3,281	1,976	0	0	0	0	0	640	1,233	1,233	--
Utah	22,341	20,213	4,258	2,019	6,229	3,785	3,670	0	0	0	0	252	2,128	2,128	--
Total	413,657	404,702	91,143	82,363	73,021	55,502	40,821	28,847	15,366	6,476	5,972	5,191	8,955	8,858	97

1/ Includes Jeffrey pine.
2/ Includes white and blue spruce.
3/ Includes grand, white, subalpine, corkbark, and California red firs.
4/ Includes sugar pine.
5/ Limber and whitebark pine, incense cedar.
6/ Less than 0.5 million board feet.

Table 14.--VOLUME OF GROWING STOCK AND SAWTIMBER ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY SPECIES AND DIAMETER GROUPS, 1962

Diameter group	All species	Softwoods								All hardwoods
		All softwoods	Douglas-fir	Ponderosa pine[1]	Engelmann spruce[2]	True firs[3]	Western white pine[4]	Western hemlock	Other[5] softwoods	
Inches	Million cubic feet									
5.0 - 8.9	18,498	18,498	2,829	2,103	1,610	3,221	228	311	8,196	
[6] 5.0 - 10.9	3,472	0	0	0	0	0	0	0	0	3,472
9.0 - 18.9	47,075	47,075	9,477	7,581	8,147	6,979	1,177	1,027	12,687	0
[6] 11.0 - 18.9	1,579	0	0	0	0	0	0	0	0	1,579
19.0 - 29.9	20,865	20,733	4,675	5,883	3,757	2,023	860	143	3,392	132
30.0+	6,269	6,266	1,656	2,287	727	395	408	11	782	3
Total	97,758	92,572	18,637	17,854	14,241	12,618	2,673	1,492	25,057	5,186
	Million board feet, International ¼-inch log rule									
9.0 - 18.9	242,759	242,759	50,778	34,249	44,722	39,435	7,034	5,504	61,037	
[6] 11.0 - 18.9	8,211	0	0	0	0	0	0	0	0	8,211
19.0 - 29.9	121,777	121,047	30,006	30,746	23,523	13,621	5,876	902	16,373	730
30.0+	40,910	40,896	10,359	17,368	4,776	2,446	2,456	70	3,421	14
Total	413,657	404,702	91,143	82,363	73,021	55,502	15,366	6,476	80,831	8,955

[1] Includes Jeffrey pine.
[2] Includes white and blue spruce.
[3] Includes grand, white, subalpine, corkbark, and California red firs.
[4] Includes sugar pine.
[5] Includes limber pine, whitebark pine, lodgepole pine, incense cedar, western larch, and western redcedar.
[6] Hardwoods only.

Table 15.--NET ANNUAL GROWTH AND CUT OF GROWING STOCK ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY SPECIES, 1962

State	Total all species		Softwoods														All hardwoods	
			All softwoods		Douglas-fir		Ponderosa pine[1]		Engelmann spruce[2]		True firs[3]		Western white pine[4]		Other softwoods[5]			
	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut
	Thousand cubic feet																	
Idaho	283,100	270,275	280,100	270,120	71,229	61,438	24,957	48,129	19,495	12,606	56,636	59,295	26,806	39,980	80,977	48,672	3,000	155
Montana	197,500	222,876	195,700	222,805	49,372	74,352	20,790	32,028	10,600	29,149	17,491	4,501	3,683	5,385	93,764	77,390	1,800	71
South Dakota (west)	20,582	11,756	20,483	11,756	0	0	19,408	11,755	1,075	1	0	0	0	0	--	--	99	--
Wyoming	85,315	21,764	84,903	21,749	7,490	1,007	14,463	3,990	19,828	3,230	4,344	552	0	0	38,778	12,970	412	15
Arizona	90,253	65,941	86,601	65,745	-1,398	4,115	84,669	57,558	2,348	845	289	3,142	0	0	693	85	3,652	196
Colorado	161,356	37,556	123,767	35,888	8,385	1,410	14,992	4,269	63,625	16,415	-9,831	1,183	0	0	46,596	12,611	37,589	1,668
Nevada	1,200	538	1,200	479	([6])	11	1,000	206	--	--	([6])	244	([6])	--	200	18	([6])	59
New Mexico	53,100	39,601	63,357	39,596	-422	7,443	40,543	21,587	14,108	8,465	7,536	1,841	0	0	1,592	260	-10,257	5
Utah	56,096	12,558	33,650	11,766	5,776	1,254	6,337	2,390	7,718	4,137	872	1,794	0	0	12,947	2,191	22,446	792
Total	948,502	682,865	889,761	679,904	140,432	151,030	227,159	181,912	138,797	74,848	77,337	72,552	30,489	45,365	275,547	154,197	58,741	2,961

[1] Includes Jeffrey pine.
[2] Includes white and blue spruce.
[3] Includes grand, white, subalpine, corkbark, and California red firs.
[4] Includes sugar pine.
[5] Includes limber pine, whitebark pine, lodgepole pine, incense cedar, western larch, western redcedar, and western hemlock.
[6] Less than 0.5 thousand cubic feet.

Table 16.--NET ANNUAL GROWTH AND CUT OF SAWTIMBER ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY SPECIES, 1962

State	Total all species		Softwoods					
			All softwoods		Douglas-fir		Ponderosa pine[1]	
	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut
	- - - - - - - Thousand board feet, International ¼-inch log rule - - - - - - -							
Idaho	1,212,000	1,561,541	1,210,000	1,560,752	341,220	354,291	161,535	277,814
Montana	892,000	1,380,927	885,000	1,380,492	301,171	465,226	170,908	220,879
South Dakota (west)	46,237	52,717	46,148	52,717	0	0	42,503	52,712
Wyoming	278,951	124,104	286,826	124,095	27,135	5,706	57,346	22,824
Arizona	344,078	404,850	341,743	404,456	-11,626	25,481	340,022	353,899
Colorado	514,256	195,601	423,742	194,216	7,879	7,574	62,406	23,112
Nevada	5,000	2,947	5,000	2,671	(6/)	61	4,000	1,149
New Mexico	216,190	241,412	229,373	241,391	-2,367	45,381	153,582	131,558
Utah	94,435	67,251	74,664	65,159	11,896	6,969	23,371	13,222
Total	3,603,147	4,031,350	3,502,496	4,025,949	675,308	910,689	1,015,673	1,097,169

State	Softwoods								All hardwoods	
	Engelmann spruce[2]		True firs[3]		Western white pine[4]		Other softwoods[5]			
	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut
	- - - - - - - - - - Thousand board feet, International ¼-inch log rule - - - - - - - - - - - - - - -									
Idaho	108,537	73,355	279,631	343,365	136,851	230,991	182,226	280,936	2,000	789
Montana	58,670	189,127	38,638	28,990	30,719	37,273	284,894	438,997	7,000	435
South Dakota (west)	3,645	5	0	0	0	0	--	--	89	--
Wyoming	94,787	18,483	46	3,101	0	0	107,512	73,981	-7,875	9
Arizona	12,665	5,258	-1,890	19,414	0	0	2,572	404	2,335	394
Colorado	303,249	88,757	-57,644	6,409	0	0	107,852	68,364	90,514	1,385
Nevada	--	--	(6/)	1,360	(6/)	--	1,000	101	(6/)	276
New Mexico	65,772	51,658	9,627	11,104	0	0	2,759	1,690	-13,183	21
Utah	26,413	22,928	-591	9,901	0	0	13,575	12,139	19,771	2,092
Total	673,738	449,571	267,817	423,644	167,570	268,264	702,390	876,612	100,651	5,401

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[1] Includes Jeffrey pine.
[2] Includes white and blue spruce.
[3] Includes grand, white, subalpine, corkbark, and California red firs.
[4] Includes sugar pine.
[5] Includes limber pine, whitebark pine, lodgepole pine, incense cedar, western larch, western redcedar, and western hemlock.
[6] Less than 0.5 thousand board feet.

Table 17.--NET ANNUAL GROWTH AND CUT OF GROWING STOCK ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY OWNERSHIP, 1962

State	All ownerships		National Forest		Other public 1/		Private	
	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut
	Thousand cubic feet							
Idaho	283,100	270,275	212,600	131,083	24,393	36,487	46,107	102,705
Montana	197,500	222,876	128,700	125,625	17,639	10,936	51,161	86,315
South Dakota (west)	20,582	11,756	14,424	10,938	1,242	32	4,916	786
Wyoming	85,315	21,764	63,634	19,431	6,648	1,305	15,033	1,028
Arizona	90,253	65,941	--	48,005	--	11,210	--	6,726
Colorado	161,356	37,556	119,394	30,759	9,199	3,605	32,763	3,192
Nevada	1,200	538	162	37	--	--	1,038	501
New Mexico	53,100	39,601	--	20,712	--	4,474	--	14,415
Utah	56,096	12,558	55,205	11,374	-1,467	251	2,358	933
Total	2/ 948,502	682,865	594,119	397,964	57,654	68,300	153,376	216,601

1/ Bureau of Land Management lands, Indian lands, miscellaneous Federal lands, State, county, and municipal lands.

2/ Growth totals by separate ownerships do not add to "all ownerships" growth total because growth data for Arizona and New Mexico were statistically too unreliable to be shown separately by ownerships.

Table 18.--NET ANNUAL GROWTH AND CUT OF SAWTIMBER ON COMMERCIAL FOREST LAND IN THE ROCKY MOUNTAIN STATES, BY OWNERSHIP, 1962

State	All ownerships		National Forest		Other public 1/		Private	
	Growth	Cut	Growth	Cut	Growth	Cut	Growth	Cut
	Thousand board feet, International ¼-inch log rule							
Idaho	1,212,000	1,561,541	819,000	757,348	136,803	210,807	256,197	593,386
Montana	892,000	1,380,927	587,000	778,798	80,731	67,713	224,269	534,416
South Dakota (west)	46,237	52,717	25,958	49,048	4,489	142	15,790	3,527
Wyoming	278,951	124,104	181,802	110,799	30,269	7,444	66,880	5,861
Arizona	344,078	404,850	--	294,731	--	68,824	--	41,295
Colorado	514,256	195,601	363,962	160,197	35,823	18,778	114,471	16,626
Nevada	5,000	2,947	743	206	18	--	4,239	2,741
New Mexico	216,190	241,412	--	126,259	--	27,279	--	87,874
Utah	94,435	67,251	119,824	60,915	-17,008	1,345	-8,381	4,991
Total	2/ 3,603,147	4,031,350	2,098,289	2,338,301	271,125	402,332	673,465	1,290,717

1/ Bureau of Land Management lands, Indian lands, miscellaneous Federal lands, State, county, and municipal lands.

2/ Growth totals by separate ownerships do not add to "all ownerships" growth total because growth data for Arizona and New Mexico were statistically too unreliable to be shown separately by ownerships.

Table 19.--ESTIMATED VOLUME OF ROUND TIMBER PRODUCTS HARVESTED IN THE ROCKY MOUNTAIN STATES, 1962 AND 1958

State	1962					1958[1]				
	Total	Saw logs	Veneer logs	Pulpwood	All other products[2]	Total	Saw logs	Veneer logs	Pulpwood	All other products[2]
	Thousand cubic feet									
Idaho	249,231	235,192	2,797	4,897	6,345	246,150	216,850	1,550	13,100	14,650
Montana	207,289	182,423	15,824	3,781	5,261	157,500	139,500	1,550	5,050	11,400
South Dakota (west)	11,235	6,493	--	3,060	1,682	19,750	10,950	--	100	8,700
Wyoming	20,771	19,617	--	464	690	19,050	15,850	--	550	2,650
Arizona	65,529	49,555	--	7,947	8,027	53,350	45,700	--	100	7,550
Colorado	36,433	31,563	--	257	4,613	40,200	31,550	--	2,200	6,450
Nevada	846	407	--	--	439	5,400	4,900	--	--	500
New Mexico	46,259	35,905	--	--	10,354	46,200	36,300	--	--	9,900
Utah	12,005	10,845	--	--	1,160	11,550	8,650	--	--	2,900
Total	649,598	572,000	18,621	20,406	38,571	599,150	510,250	3,100	21,100	64,700

[1] See Bibliography item (22, p. 32). South Dakota data for 1958 are for the entire State but are still useful for comparison with 1962 since practically all of the State's output is from the Black Hills in the western end of the State.

[2] Includes products such as commercial poles, houselogs, converter poles, shingle logs and bolts, excelsior bolts, match splint logs, charcoal wood, round mine timbers, posts, fuelwood, and miscellaneous farm timbers.

Table 20.--ROUNDWOOD PRODUCTS AND LOGGING RESIDUES FROM GROWING STOCK IN THE ROCKY MOUNTAIN STATES, 1962

State	Total products and residues	Roundwood products								Logging residues
		All products	Saw logs	Veneer logs	Round pulpwood	Commercial poles	Round mine timbers	Miscellaneous industrial wood[1]	Posts, fuelwood, miscellaneous farm timbers	
	Thousand cubic feet									
Idaho	270,275	238,690	228,374	2,797	3,080	2,673	177	113	1,476	31,585
Montana	222,876	196,873	175,455	15,824	2,701	966	67	281	1,579	26,003
South Dakota (west)	11,756	11,062	6,428	--	3,060	[2]516	--	--	1,058	694
Wyoming	21,764	19,996	19,225	--	334	7	21	15	394	1,768
Arizona	65,941	57,122	47,870	--	7,947	125	524	210	446	8,819
Colorado	37,556	34,366	30,490	--	203	482	1,331	1,316	544	3,190
Nevada	538	489	403	--	--	--	--	53	33	49
New Mexico	39,601	33,592	32,638	--	--	18	387	91	458	6,009
Utah	12,558	11,233	10,357	--	--	4	147	684	41	1,325
Total	682,865	603,423	551,240	18,621	17,325	4,791	2,654	2,763	6,029	79,442

[1] Includes products such as house logs, converter poles, shingle logs and bolts, excelsior bolts, match splint logs, and charcoal wood.
[2] Includes a small amount of piling.

Table 21.--OUTPUT OF ROUNDWOOD PRODUCTS IN THE ROCKY MOUNTAIN STATES, IN STANDARD UNITS, 1962

State	Saw logs			Veneer logs			Round mine timbers			Miscellaneous industrial wood1/			Miscellaneous farm timbers		
	All species	Softwoods	Hard-woods	All species	Softwoods	Hard-woods	All species	Soft-woods	Hard-woods	All species	Soft-woods	Hard-woods	All species	Soft-woods	Hard-woods
	Thousand board feet2/						Thousand cubic feet								
Idaho	1,547,334	1,546,858	476	19,030	18,750	280	223	223	--	124	108	16	2,302	2,302	--
Montana	1,275,688	1,275,242	446	110,654	110,654	--	271	270	1	281	281	--	2,108	2,108	--
South Dakota (west)	38,958	38,958	--	--	--	--	--	--	--	--	--	--	447	447	--
Wyoming	116,523	116,523	--	--	--	--	54	54	--	39	24	15	409	409	--
Arizona	341,757	341,757	--	--	--	--	556	556	--	389	34	355	97	77	20
Colorado	184,645	183,490	1,155	--	--	--	1,411	1,409	2	1,316	140	1,176	373	343	30
Nevada	2,437	2,437	--	--	--	--	--	--	--	53	11	42	2	1	1
New Mexico	247,620	247,620	(6/)	--	--	--	410	410	--	91	91	(6/)	183	160	23
Utah	64,938	62,916	2,022	--	--	--	245	245	--	703	306	397	88	83	5
Total	3,819,900	3,815,801	4,099	129,684	129,404	280	3,170	3,167	3	2,996	995	2,001	6,009	5,930	79

State	Round pulpwood			Fuelwood			Commercial poles			Posts		
	All species	Soft-woods	Hard-woods	All species	Soft-woods	Hard-woods	All species	Soft-woods	Hard-woods	All species	Soft-woods	Hard-woods
	Thousand standard cords						Thousand pieces					
Idaho	66	66	--	5	5	(3/)	150	150	--	818	818	--
Montana	47	47	--	4	4	--	122	122	--	1,047	1,047	--
South Dakota (west)	34	34	--	1	1	--	4/91	91	--	599	599	--
Wyoming	4	4	--	1	1	--	(5/)	(5/)	(5/)	79	79	--
Arizona	88	88	--	97	80	17	9	9	--	173	171	2
Colorado	3	1	2	10	8	2	53	53	--	368	368	--
Nevada	--	--	--	4	3	1	--	--	--	38	38	--
New Mexico	--	--	--	134	131	3	3	3	(7/)	235	230	5
Utah	--	--	--	1	1	--	(5/)	(5/)	(5/)	16	16	--
Total	242	240	2	257	234	23	8/428	8/428	--	3,373	3,366	7

1/ Includes products such as house logs, converter poles, shingle logs and bolts, excelsior bolts, match splint logs, and charcoal wood.
2/ International ¼-inch log rule.
3/ Less than 0.5 M standard cords.
4/ Includes some piling.
5/ Withheld to avoid disclosing individual operations.
6/ A small quantity of hardwoods has been combined with softwoods to avoid disclosing individual operations.
7/ Less than 0.5 thousand pieces.
8/ Does not include numbers of poles for Wyoming and Utah. These were withheld to avoid disclosing individual operations.

Table 22.--ESTIMATED VOLUME OF PLANT RESIDUES[1] IN THE ROCKY MOUNTAIN STATES, BY INDUSTRIAL SOURCE, 1962

State	All industries			Lumber industry			Veneer and plywood industry			Other primary industries		
	Total	Coarse[2]	Fine[3]	Total	Coarse[2]	Fine[3]	Total	Coarse[2]	Fine[3]	Total	Coarse[2]	Fine[3]
	Thousand cubic feet											
Idaho	80,330	40,124	40,206	78,448	38,242	40,206	941	941	--	941	941	--
Montana	62,625	26,075	36,550	57,192	20,642	36,550	5,033	5,033	--	400	400	--
South Dakota (west)	2,747	1,144	1,603	2,534	931	1,603	--	--	--	213	213	--
Wyoming	8,583	3,610	4,973	8,566	3,593	4,973	--	--	--	17	17	--
Arizona	10,371	3,999	6,372	10,268	3,896	6,372	--	--	--	103	103	--
Colorado	15,875	8,292	7,583	15,019	7,436	7,583	--	--	--	856	856	--
Nevada	252	150	102	223	121	102	--	--	-	29	29	--
New Mexico	17,843	8,431	9,412	17,790	8,378	9,412	--	--	--	53	53	--
Utah	4,695	2,683	2,012	4,413	2,401	2,012	--	--	--	282	282	--
Total	203,321	94,508	108,813	194,453	85,640	108,813	5,974	5,974	--	2,894	2,894	--

[1] Unused plant residues at primary manufacturing plants; i.e., do not include primary plant waste that is subsequently used for fuel or fiber (pulp or particle board).

[2] Unused material suitable for chipping, such as slabs, edgings, veneer cores, and trimmings.

[3] Unused material such as sawdust and shavings.

Table 23.--LUMBER PRODUCTION IN THE ROCKY MOUNTAIN STATES, 1952-1964[1]

State	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
	Million board feet, lumber tally												
Idaho	1,106	1,101	1,399	1,413	1,608	1,277	1,437	1,802	1,405	1,467	1,516	1,568	1,656
Montana	702	757	738	785	981	773	924	1,044	985	985	1,069	1,175	1,221
South Dakota[2]	--	--	37	--	--	--	72	--	52	46	50	50	57
Wyoming	--	--	81	--	--	[3]109	105	107	99	97	103	112	132
Arizona	--	--	258	--	--	--	303	--	330	326	326	352	411
Colorado	--	--	174	--	--	[4]188	209	227	181	197	208	204	257
Nevada	--	--	28	--	--	--	--	--	34	31	37	33	36
New Mexico	--	--	222	--	--	--	241	--	228	226	245	223	265
Utah	--	--	51	--	--	--	--	--	69	66	67	74	69
Total	2,498	2,624	2,988	3,085	3,587	3,120	3,381	3,990	3,383	3,441	3,621	3,791	4,104

[1] See Bibliography items (54 through 59, 61 through 64, 66).

[2] Data for entire State. The Bureau of the Census does not report data separately for western South Dakota. However, more than 90 percent of the State's timber industry occurs in western South Dakota.

[3] See (45).

[4] See (42).

Table 24.--NUMBERS OF ACTIVE SAWMILLS AND LUMBER PRODUCTION PER MILL IN THE ROCKY MOUNTAIN STATES FOR 1962 AND PREVIOUS YEARS

State	Previous year of record			1962	
	Year	No. of mills	Output per mill	No. of mills	Output per mill
			- - MBF - -		- - MBF - -
Idaho	1956	311	5,174	193	7,855
Montana	1956	333	2,946	209	5,115
South Dakota (west)	--	--	--	28	1/1,714
Wyoming	1957	107	1,016	76	1,355
Arizona	1960	38	8,680	28	11,643
Colorado	1957	274	686	170	1,224
Nevada	--	--	--	(2/)	(2/)
New Mexico	1960	117	1,947	85	2,882
Utah	1960	99	700	2/75	2/1,387
All mills		--	--	864	4,189

1/ Census Bureau's estimate of lumber production for the State is 50 million board feet. In 1962, western South Dakota sawmills received 96.3 percent of all saw logs received in the State. On this basis, the lumber production in western South Dakota was 48 million board feet, and output per mill was 1,714 MBF.

2/ Nevada and Utah data are combined for computing the average for 1962 because of the amall number of active mills in Nevada.

Table 25.--NUMBERS AND PRODUCTION OF ACTIVE SAWMILLS IN THE ROCKY MOUNTAIN STATES, 1962 AND PREVIOUS YEARS

State	Year	Previous year of record												1962											
		Small1/				Medium1/				Large1/				Small1/				Medium1/				Large1/			
		Mills		Production		Mills		Production		Mills		Production		Mills		Production		Mills		Production		Mills		Production	
		No.	%	MMBF	%	No.	%	MMBF	%	No.	%	MMBF	%	No.	%	MMBF	%	No.	%	MMBF	%	No.	%	MMBF	%
Idaho	1956	166	53	33	2	108	35	410	25	37	12	1,166	73	70	36	26	2	81	42	306	20	42	22	1,184	78
Montana	1956	229	69	65	6	78	23	263	27	26	8	653	67	129	62	25	2	40	19	109	11	40	19	935	87
South Dakota (west)	--	--	--	--	--	--	--	--	--	--	--	--	--	21	75	6	13	7	25	42	87	--	--	--	--
Wyoming	1957	85	79	22	20	22	21	87	80	--	--	--	--	57	75	13	12	19	25	90	88	--	--	--	--
Arizona	2/1960	11	29	3	1	27	71	327	99	--	--	--	--	8	29	2	1	20	71	324	99	--	--	--	--
Colorado	1957	227	83	53	28	47	17	135	72	--	--	--	--	125	74	32	16	45	26	176	84	--	--	--	--
Nevada3/	--	--	--	--	--	--	--	--	--	--	--	--	--			(3/)				(3/)		--	--	--	--
New Mexico	1960	80	68	34	15	37	32	194	85	--	--	--	--	54	64	18	7	31	36	227	93	--	--	--	--
Utah3/	1960	87	88	23	32	12	12	47	68	--	--	--	--	56	75	9	9	19	25	95	91	--	--	--	--
Total		--	--	--	--	--	--	--	--	--	--	--	--	520	--	131	--	4/344	--	4/3,488	--	--	--	--	--

1/ Small mill: Less than 1 million board feet per year. Medium: 1 to 10 million per year. Large: More than 10 million board feet per year. The "medium" class for western South Dakota, Wyoming, Arizona, Colorado, New Mexico, and Utah actually includes data for all mills producing more than 1 MMBF to avoid disclosing operations data of the few mills that produce more than 10 MMBF per year.

2/ See bibliography item (43).

3/ Nevada and Utah data are combined for 1962 because of the small number of active mills in Nevada. Data shown for 1960 are for Utah only.

4/ Totals are combined for numbers and production of medium and large mills.

Table 26.--NUMBERS OF ACTIVE SAWMILLS BY SIZE CLASSES IN THE ROCKY MOUNTAIN STATES, 1962

State	Sawmill size class in thousands of board feet per year[1]						Total
	Less than 50	50 to 499	500 to 999	1,000 to 4,999	5,000 to 9,999	10,000 and over	
Idaho	15	39	16	53	28	42	193
Montana	50	52	27	30	10	40	209
South Dakota (west)	5	13	3	5	1	1	28
Wyoming	14	38	5	12	4	3	76
Arizona	--	8	--	7	2	11	28
Colorado	37	68	20	37	3	5	170
New Mexico	12	26	16	19	4	8	85
Utah and Nevada	19	33	5	16	--	2	75
Total	152	277	92	179	52	112	864

[1] Mill size class is ordinarily based on annual lumber production but is based on reported saw log receipts (expressed in International ¼-inch log rule volumes) in this table.

Table 27.--OUTPUT OF ALL TIMBER PRODUCTS IN THE ROCKY MOUNTAIN STATES, BY SELECTED YEARS, 1952-1962

State	1952[1]	1954[2]	1956	1957	1958[2]	1960	1962
	Thousand cubic feet						
Idaho	196,566	230,000	[3]327,907	--	246,150	--	249,231
Montana	117,233	126,750	[4]191,626	--	157,500	--	207,289
South Dakota (west)	7,493	[5]8,250	--	--	[5]19,750	--	11,235
Wyoming	12,888	15,200	--	[6]19,388	19,050	--	20,771
Arizona	48,970	52,900	--	--	53,350	[7]61,589	65,529
Colorado	33,055	32,500	--	[6]44,200	40,200	--	36,433
Nevada	307	4,500	--	--	5,400	[8]3,158	846
New Mexico	28,727	50,350	--	--	46,200	[7]53,028	46,259
Utah	6,765	10,350	--	--	11,550	[8]14,831	12,005
Total	452,004	--	--	--	--	--	649,598

[1] See Bibliography item (68, pp. 526-527, 572-573).
[2] See (22, pp. 32-33).
[3] See (81, p. 10).
[4] See (82, p. 10).
[5] South Dakota data for 1954 and 1958 are for the entire State.
[6] See (53, pp. 6 and 13).
[7] See (83, p.7).
[8] See (51, pp. 4 and 8).

Table 28.--OUTPUT OF TIMBER PRODUCTS IN THE ROCKY MOUNTAIN STATES, BY SPECIES, 1962

State	All species	Softwoods									All hardwoods
		All softwoods	Douglas-fir	Ponderosa pine	Engelmann spruce[1]	True firs[2]	Western white pine	Lodgepole pine	Western larch	Other softwoods[3]	
	Thousand cubic feet										
Idaho	249,231	249,092	56,748	43,898	11,994	54,023	37,171	3,536	18,507	23,215	139
Montana	207,289	207,224	68,734	29,428	27,900	4,122	4,939	19,994	49,314	2,793	65
South Dakota (west)	11,235	11,235	0	11,234	1	0	0	--	0	-	--
Wyoming	20,771	20,756	951	3,736	3,038	516	0	12,510	0	5	15
Arizona	65,529	63,981	3,610	53,278	741	2,755	0	0	0	3,597	1,548
Colorado	36,433	34,740	1,452	4,183	15,750	1,161	0	12,189	0	5	1,693
Nevada	846	723	24	246	--	218	--	16	0	219	123
New Mexico	46,259	45,992	6,927	22,802	7,878	1,717	0	0	0	6,668	267
Utah	12,005	11,264	1,174	2,306	3,964	1,739	0	2,066	0	15	741
Total	649,598	645,007	139,620	171,111	71,266	66,251	42,110	50,311	67,821	36,517	4,591

[1] Engelmann. blue, and white spruce.
[2] Grand, white, subalpine, and corkbark firs.
[3] Includes western redcedar, western hemlock, pinyon pine, bristlecone pine, limber pine, whitebark pine, and juniper.

Table 29.--OUTPUT OF TIMBER PRODUCTS IN THE ROCKY MOUNTAIN STATES, BY LAND OWNERSHIP CLASSES, 1962

State	All ownerships	Land ownership class			
		National Forest	Other public	Forest industry[1]	Other private
	Thousand cubic feet				
Idaho	249,231	120,129	33,646	64,053	31,403
Montana	207,289	115,460	10,572	44,360	36,897
South Dakota (west)	11,235	9,426	56	360	1,393
Wyoming	20,771	18,569	1,225	478	499
Arizona	65,529	45,412	14,154	3,473	2,490
Colorado	36,433	29,620	3,170	401	3,242
Nevada	846	65	24	671	86
New Mexico	46,259	19,891	9,622	--	16,746
Utah	12,005	10,324	228	12	1,441
Total	649,598	368,896	72,697	113,808	94,197

[1] Lands owned by companies or individuals operating wood-using plants.

Table 30.--DISTRIBUTION OF TIMBER PRODUCTS OUTPUT IN THE ROCKY MOUNTAIN STATES, BY PRODUCTS, 1962

State	All products		Saw logs		Veneer logs		Round pulpwood		Commercial poles		Round mine timbers		Miscellaneous industrial wood		Posts, fuelwood miscellaneous farm timbers	
	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%	M cu.ft.	%
Idaho	249,231	38.4	235,192	41.1	2,797	15.0	4,897	24.0	2,673	55.3	223	7.0	124	4.1	3,325	12.0
Montana	207,289	31.9	182,423	31.9	15,824	85.0	3,781	18.5	966	20.0	271	8.6	281	9.4	3,743	13.6
South Dakota (west)	11,235	1.7	6,493	1.2	--	--	3,060	15.0	548	11.4	--	--	--	--	1,134	4.1
Wyoming	20,771	3.2	19,617	3.4	--	--	464	2.3	--	--	54	1.7	39	1.3	597	2.2
Arizona	65,529	10.1	49,555	8.6	--	--	7,947	38.9	125	2.6	556	17.6	389	13.0	6,957	25.2
Colorado	36,433	5.6	31,563	5.5	--	--	257	1.3	482	9.9	1,411	44.5	1,316	44.0	1,404	5.1
Nevada	846	.1	407	.1	--	--	--	--	--	--	--	--	53	1.8	386	1.4
New Mexico	46,259	7.1	35,905	6.3	--	--	--	--	33	.7	410	12.9	91	3.0	9,820	35.6
Utah	12,005	1.9	10,845	1.9	--	--	--	--	4	.1	245	7.7	699	23.4	212	.8
Total	649,598	100.0	572,000	100.0	18,621	100.0	20,406	100.0	4,831	100.0	3,170	100.0	2,992	100.0	27,578	100.0

Table 31.--DISTRIBUTION OF TIMBER PRODUCTS OUTPUT, ROCKY MOUNTAIN STATES, BY SELECTED YEARS, 1952-1962

State	1952	1954	1958	1962
		Percent		
Idaho	43.5	43.3	41.1	38.4
Montana	25.9	23.9	26.3	31.9
South Dakota (west)	1.7	[1]1.5	[1]3.3	1.7
Wyoming	2.8	2.9	3.2	3.2
Arizona	10.8	10.0	8.9	10.1
Colorado	7.3	6.1	6.7	5.6
Nevada	.1	.8	.9	.1
New Mexico	6.4	9.5	7.7	7.1
Utah	1.5	2.0	1.9	1.9
Total	100.0	100.0	100.0	100.0

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[1] Computed from data for entire State; separate data for western South Dakota not available for 1954 and 1958.

Table 32.--GENERAL STATISTICS ON EMPLOYMENT, VALUE ADDED IN MANUFACTURE, AND CAPITAL EXPENDITURES FOR LUMBER AND WOOD PRODUCTS INDUSTRIES (SIC CODE 24), SAWMILLS AND PLANING MILLS (SIC CODE 242), AND ALL MANUFACTURING INDUSTRIES IN THE ROCKY MOUNTAIN STATES, 1958 AND 1963

State	Census Bureau SIC code number	1958 [1]						1963 [2]					
		All employees		Production workers		Value added by manufacture, adjusted	Capital expenditures, new	All employees		Production workers		Value added by manufacture	Capital expenditures, new
		Number	Payroll	Number	Wages			Number	Payroll	Number	Wages		
			$1,000		$1,000				$1,000		$1,000		
Idaho	24	10,337	47,462	9,339	41,387	66,990	5,958	10,624	53,704	9,661	47,845	89,334	11,780
	242	7,551	33,692	6,899	29,653	47,889	3,338	7,336	37,324	6,759	33,432	62,237	7,816
	All	27,582	126,015	22,149	96,509	255,258	18,409	30,809	162,470	24,373	116,556	365,695	28,140
Montana	24	6,669	29,213	5,868	24,363	47,549	6,756	8,325	41,043	7,426	35,298	67,294	9,256
	242	4,985	21,945	4,415	18,412	36,110	5,014	5,372	26,993	4,765	22,890	43,059	5,552
	All	20,315	94,090	15,762	70,428	196,915	21,693	20,279	108,090	16,009	81,436	234,783	27,960
South Dakota[3]	24	1,040	3,498	879	2,788	4,816	365	700	2,799	600	2,275	4,535	586
	242	756	2,434	656	2,024	3,250	284	377	1,586	343	1,387	2,436	([4])
	All	12,901	54,786	9,631	37,452	114,256	5,211	13,403	70,670	9,803	48,305	142,230	7,351
Wyoming	24	850	3,262	768	2,890	4,612	529	1,152	4,341	1,038	3,854	7,856	974
	242	667	2,551	604	2,261	3,531	457	755	2,887	688	2,613	5,477	663
	All	6,704	31,173	4,699	22,245	62,558	6,985	6,913	37,919	4,831	25,317	82,978	14,189
Arizona	24	2,831	11,877	2,528	10,014	15,378	1,478	3,136	14,926	2,707	12,433	24,295	2,607
	242	2,073	8,695	1,860	7,492	10,567	1,035	--	--	--	--	--	--
	All	40,850	214,390	29,980	148,325	360,173	27,698	57,339	349,124	38,687	212,187	617,413	49,154
Colorado	24	2,642	9,036	2,294	7,554	12,801	2,691	2,419	9,340	2,131	7,771	15,937	1,650
	242	1,593	5,259	1,414	4,555	7,772	1,818	1,418	5,625	1,283	4,782	8,891	1,068
	All	77,574	390,918	55,084	265,209	781,943	45,833	92,659	591,473	64,159	368,907	1,202,958	68,032
Nevada	24	504	2,310	452	1,984	3,526	91	362	1,967	327	1,647	4,654	297
	242	182	908	165	766	1,541	3	--	--	--	--	--	--
	All	5,034	26,780	3,677	18,868	67,591	5,155	6,965	43,499	4,999	29,415	111,733	8,760
New Mexico	24	1,812	6,161	1,616	5,351	11,559	818	2,226	8,405	1,984	6,994	13,621	1,791
	242	1,220	4,112	1,083	3,540	6,315	553	1,402	5,064	1,275	4,183	8,538	1,178
	All	13,740	58,694	9,795	37,950	114,897	15,423	15,236	81,249	10,091	46,598	170,453	9,491
Utah	24	741	2,473	584	1,895	3,041	653	884	3,482	779	2,893	4,878	664
	242	448	1,332	345	973	1,609	371	458	1,688	425	1,482	2,209	([4])
	All	37,633	181,040	26,717	120,751	411,785	29,516	53,329	326,371	33,374	181,518	704,629	29,757
Total	24	27,426	115,292	24,328	98,226	170,272	19,339	[5] 29,828	[5] 140,007	[5] 26,653	[5] 121,010	[5] 232,404	[6] 29,605
	242	19,475	80,928	17,441	69,676	118,584	12,873	17,118	81,167	15,538	70,769	132,847	16,277
	All	242,333	1,177,886	177,494	817,737	2,365,376	175,923	296,932	1,770,865	206,326	1,110,239	3,632,872	242,834

[1] Data and terms are as shown in Bureau of the Census publications. See Bibliography item (60).

[2] See (65).

[3] Data for entire State. The Bureau of the Census does not report data separately for western South Dakota. However, more than 90 percent of the State's timber industry occurs in western South Dakota.

[4] Less than $500,000.

[5] Total for all States except Arizona and Nevada.

[6] Total for all States except South Dakota, Arizona, Nevada, and Utah.

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Colorado	6, 25, 34, 42, 44, 47, 49, 53
Idaho	14, 16, 32, 34, 73, 74, 78, 79, 80, 81
Montana	1, 3, 4, 5, 16, 17, 29, 30, 31, 34, 46 47, 48, 49, 73, 75, 78, 82
Nevada	51
New Mexico	10, 18, 19, 20, 35, 38, 39, 43, 72, 83
South Dakota (west)	7, 12, 13, 15, 34, 37, 46, 47, 49, 53
Utah	9, 33, 51, 70, 78
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APPENDIX

TERMINOLOGY

Forest Land

The term forest land includes (a) land that is at least 10-percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting an influence on the climate or on the water regime; (b) land from which the trees described in (a) have been removed to less than 10-percent stocking, and which has not been developed for other use; (c) afforested areas.

At the time the fieldwork for this report was performed, the minimum unit of area for forest land classification was 10 acres with a minimum width of stringer strips of 120 feet.

The principal classes of forest land are:

Commercial forest land.--Forest land which is (a) producing, or physically capable of producing, usable crops of wood (usually sawtimber); (b) economically available now or prospectively; (c) not withdrawn from timber utilization.

Noncommercial forest land.--Three classes of noncommercial forest land are recognized: Productive-reserved, Unproductive-nonreserved, and Unproductive-reserved.

Productive-reserved is public forest land withdrawn from timber utilization through statute, ordinance, or administrative order, but which otherwise qualifies as commercial forest land.

Unproductive indicates forest land incapable of yielding usable wood products (usually sawtimber) because of adverse site conditions, or forest land so physically inaccessible as to be unavailable economically in the foreseeable future.

Forest Types

Forest land is classified into types on the basis of tree species; the type name is that of the predominant species. The predominant species is the one which has a plurality of (a) gross cubic volume in sawtimber and poletimber stands or (b) the number of stems in seedling and sapling stands. Both growing stock and cull trees are considered in the classification. The following forest types occur on both commercial and noncommercial forest land:

Douglas-fir
Ponderosa pine
Western white pine
Lodgepole pine
Whitebark, limber, and bristlecone pines
Fir-spruce
Hemlock
Western redcedar
Western larch
Aspen
Cottonwood
Other western hardwoods

Additional forest types occur only on noncommercial forest land:

Pinyon-juniper
Chaparral
Other (unclassified)

Tree-Size Classes

Sawtimber-size tree

A tree 9.0 inches d.b.h. or larger for softwoods and 11.0 inches d.b.h. or larger for hardwoods.

Pole-size tree

A tree 5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods.

Seedling and sapling trees

Trees at least 1 foot high and less than 5.0 inches d.b.h.

Tree-Merchantability Classes

Sawtimber tree

Live tree of commercial species, 9.0 inches d.b.h. or larger for softwoods and 11.0 inches d.b.h. or larger for hardwoods, that contains at least one saw log. At least one-third of the board-foot volume must be free from rot or other defect.

Poletimber tree

Live tree of commercial species, 5.0 to 8.9 inches d.b.h. for softwoods and 5.0 to 10.9 inches d.b.h. for hardwoods, free of rot and having the likelihood of growing into a sawtimber tree.

Growing stock trees

Sawtimber trees, poletimber trees, saplings, and seedlings; i.e., all live trees except cull trees.

In discussion and tables on volumes, growth, and mortality, the term growing stock refers only to sawtimber trees and poletimber trees; i.e., all live trees 5 inches d.b.h. and larger (except cull trees). Saplings and seedlings are not part of growing stock in this use of the term.

Cull tree

Live tree of sawtimber or poletimber size that is unmerchantable for saw logs, now or prospectively, because of rot or other defect, or species.

Sound cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull with at least one-half of this cull the result of sweep, crook, or other sound defect. Also included are sound trees which do not contain at least one saw log.

b. Poletimber-size trees that are unlikely to grow into sawtimber trees because of serious fire and basal scars, broken tops, severe mistletoe, crooks, or girdling by porcupine. No rot may be present.

Rotten cull trees include:

a. Sawtimber-size trees that have more than two-thirds of their gross board-foot volume in cull, with more than half of the cull due to rot.

b. Poletimber-size trees showing any evidence of rot in the main stem.

Stand-Size Classes

Sawtimber stands

Stands at least 10-percent stocked with growing stock trees, with half or more of the total stocking in sawtimber or poletimber trees and with sawtimber stocking at least equal to poletimber stocking.

Old-growth sawtimber

A sawtimber stand in which 50 percent or more of the net board-foot volume is in trees of rotation age or older.

Young-growth sawtimber

A sawtimber stand in which 50 percent or more of the net board-foot volume is in trees under rotation age.

Poletimber stands

Stands at least 10-percent stocked with growing stock trees, of which half or more of the stocking is sawtimber and/or poletimber trees with poletimber stocking exceeding that of sawtimber.

Seedling-sapling stands

Stands at least 10-percent stocked with growing stock trees of which more than half are saplings and/or seedlings (trees less than 5.0 inches d.b.h.).

Nonstocked area

Commercial forest land less than 10-percent stocked with growing stock trees.

Timber Volume

All-timber volume

Volume in cubic feet of sound wood in the bole of growing stock, cull, and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top inside bark.

Growing stock volume

Net volume in cubic feet of sawtimber trees and poletimber trees from stump to a minimum 4.0-inch top inside bark.

Live sawtimber volume

Net volume in board feet, international $\frac{1}{4}$-inch rule, of the saw log portion of sawtimber trees.

Saw log portion

That portion of the bole of sawtimber trees between the stump and the merchantable top.

Merchantable top

The point at which the upper limit of saw log merchantability is limited either by limbs or by a minimum diameter. The latter ranges from 5 to 10 inches inside bark depending on d.b.h., species, and regional utilization standards.

Upper-stem portion

That part of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches inside bark.

Growth

Net annual growth of sawtimber or growing stock

The average annual change, calculated from the total change over a 10-year period, in net board-foot or cubic-foot volume of live sawtimber or growing stock on commercial forest land.

Mortality

Net annual mortality of sawtimber or growing stock

The average annual net board-foot or cubic-foot volume removed from live sawtimber or growing stock through death, calculated from the total net volume removed by such causes over a 10-year period.

Timber Cut

Timber cut from growing stock

The volume of sound wood in live sawtimber and poletimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Timber cut from sawtimber

The net board-foot volume of live sawtimber trees cut for forest products during a specified period, including both roundwood products and logging residues.

Logging residues from growing stock

The net cubic-foot volume of live sawtimber and poletimber trees cut or killed by logging on commercial forest land and not converted to timber products.

Ownership Classes

National Forest lands

Federal lands which have been designated by Executive order or statute as National Forests or purchase units, and other lands under the administration of the United States Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Other Federal lands

Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies.

State, county, and municipal lands

Lands owned by States, counties, and local public agencies, or lands leased by these governmental units for more than 50 years.

Forest industry lands

Lands owned by companies or individuals operating wood-using plants.

Farmer-owned lands

Lands owned by operators of farms.

Miscellaneous private lands

Privately owned lands other than forest-industry or farmer-owned lands.

Principal Tree Species

Softwoods

Douglas-fir	*Pseudotsuga menziesii*
Fir, subalpine	*Abies lasiocarpa*
Fir, corkbark	*A. lasiocarpa* var. *arizonica*
Fir, grand	*A. grandis*
Fir, white	*A. concolor*
Hemlock, mountain	*Tsuga mertensiana*
Hemlock, western	*T. heterophylla*
Juniper	*Juniperus* spp.
Larch, alpine	*Larix lyallii*
Larch, western	*L. occidentalis*
Pine, bristlecone	*Pinus aristata*
Pine, limber	*P. flexilis*
Pine, lodgepole	*P. contorta*
Pine, ponderosa	*P. ponderosa*
Pine, western white	*P. monticola*
Pine, whitebark	*P. albicaulis*
Pine, pinyon	*P.* spp.
Redcedar, western	*Thuja plicata*
Spruce, Engelmann	*Picea engelmannii*
Spruce, blue	*P. pungens*
Spruce, white	*P. glauca*

Hardwoods

Aspen, quaking	*Populus tremuloides*
Cottonwood	*P.* spp.
Birch, paper	*Betula papyrifera*

Maps

of

MAJOR TIMBER INDUSTRIES AND COMMERCIAL FOREST LAND

in the

ROCKY MOUNTAIN STATES

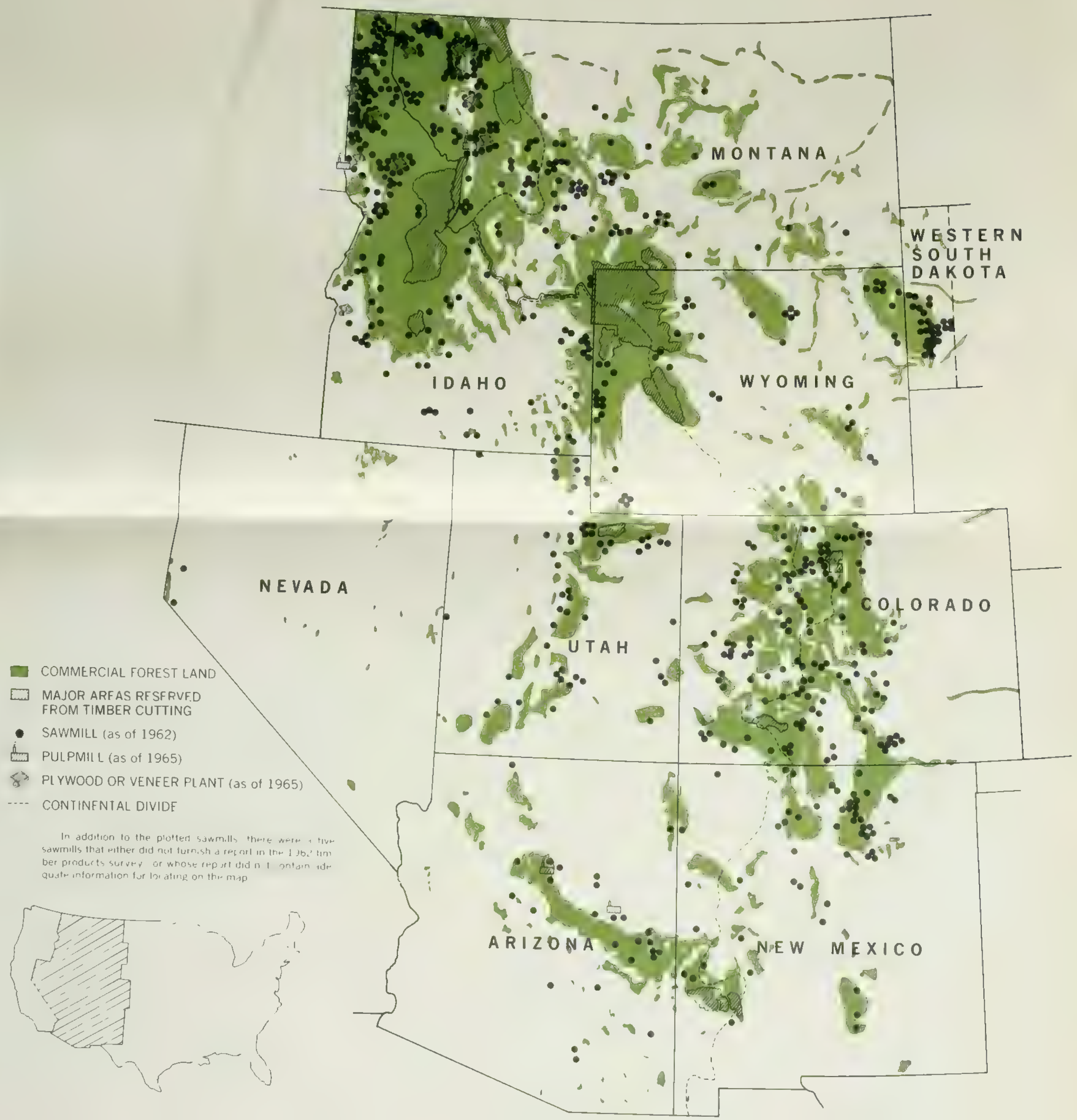
and

SAW LOG OUTPUT BY COUNTIES, 1962,

ROCKY MOUNTAIN STATES

MAJOR TIMBER INDUSTRIES AND COMMERCIAL FOREST LAND
IN THE
ROCKY MOUNTAIN STATES

FOREST SURVEY • INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
AND
ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE

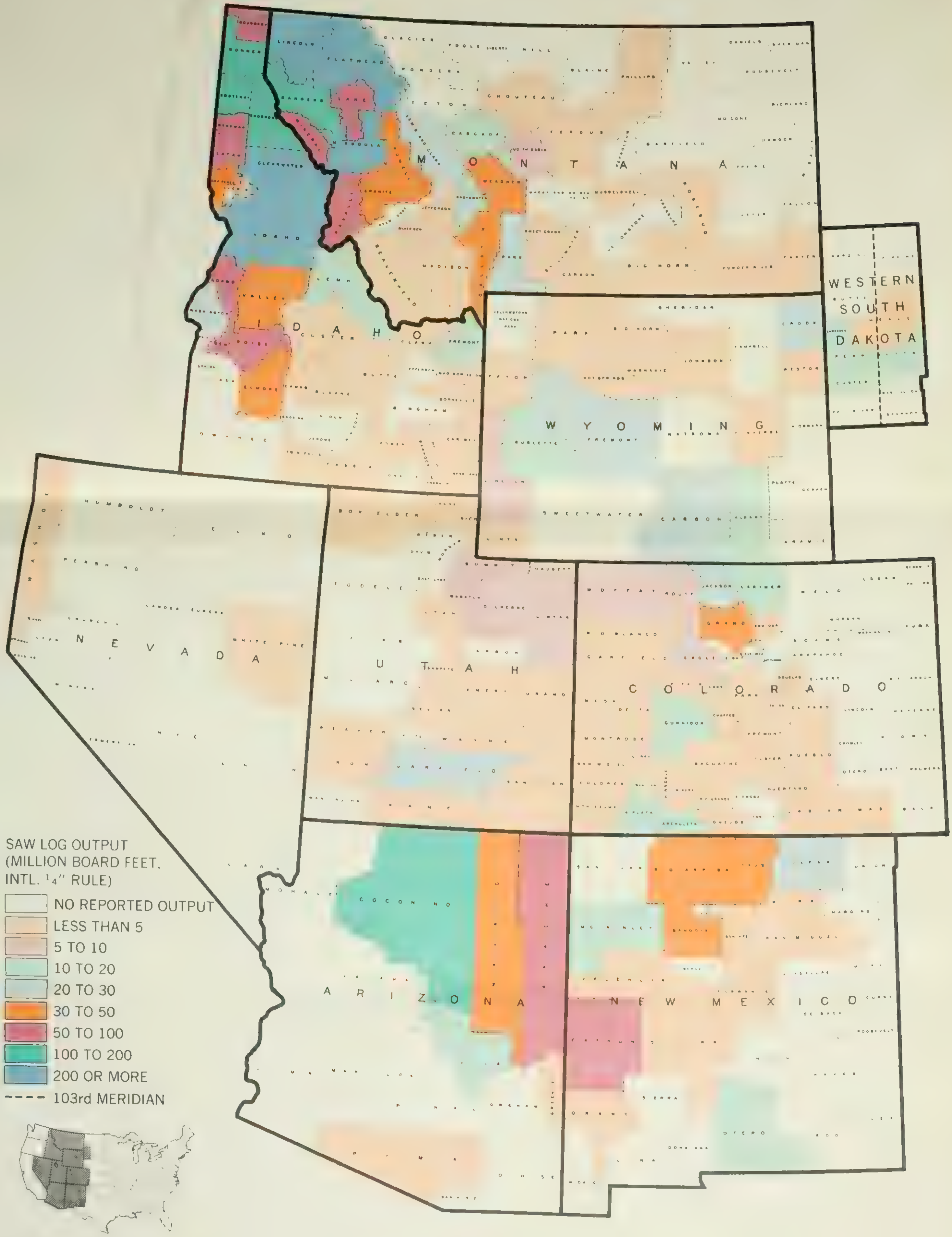


In addition to the plotted sawmills there were [illegible]tive sawmills that either did not furnish a report in the 1962 timber products survey or whose report did not contain adequate information for locating on the map.

SAW LOG OUTPUT BY COUNTIES, 1962

ROCKY MOUNTAIN STATES

FOREST SURVEY • INTERMOUNTAIN FOREST AND RANGE
EXPERIMENT STATION
AND
ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE



RECENT FOREST SURVEY PUBLICATIONS

Title	Number	Date
Timber Resources of Idaho	Forest Survey Release 3	1962
The Forest Resources of Western Montana	Resource Bulletin INT-1	1963
*The Forests of Wyoming	Resource Bulletin INT-2	1963
*The Forest Resources of Colorado	Resource Bulletin INT-3	1964
Output of Timber Products in Montana, 1962	Research Paper INT-11	1964
Forest Products Output in Utah and Nevada, 1962	Research Paper INT-12	1964
Output of Timber Products in Idaho, 1962	Research Paper INT-13	1964
*Timber Products Output in Colorado, Wyoming, and Western South Dakota, 1962	Research Paper INT-14	1964
*Timber Products Output in Arizona and New Mexico, 1962	Research Paper INT-15	1964
Forests in Utah	Resource Bulletin INT-4	1965
Site Index Curves for Engelmann Spruce in the Northern and Central Rocky Mountains	Research Note INT-42	1966
*New Mexico's Forest Resource	Resource Bulletin INT-5	1966
*Arizona's Forests	Resource Bulletin INT-6	1966

Publications may be obtained by request to:

Director, Intermountain Forest & Range Experiment Station
Forest Service Building
507 - 25th Street
Ogden, Utah 84401

*Also available by request to:

Director, Rocky Mountain Forest & Range Experiment Station
240 West Prospect Street
Fort Collins, Colorado 80521

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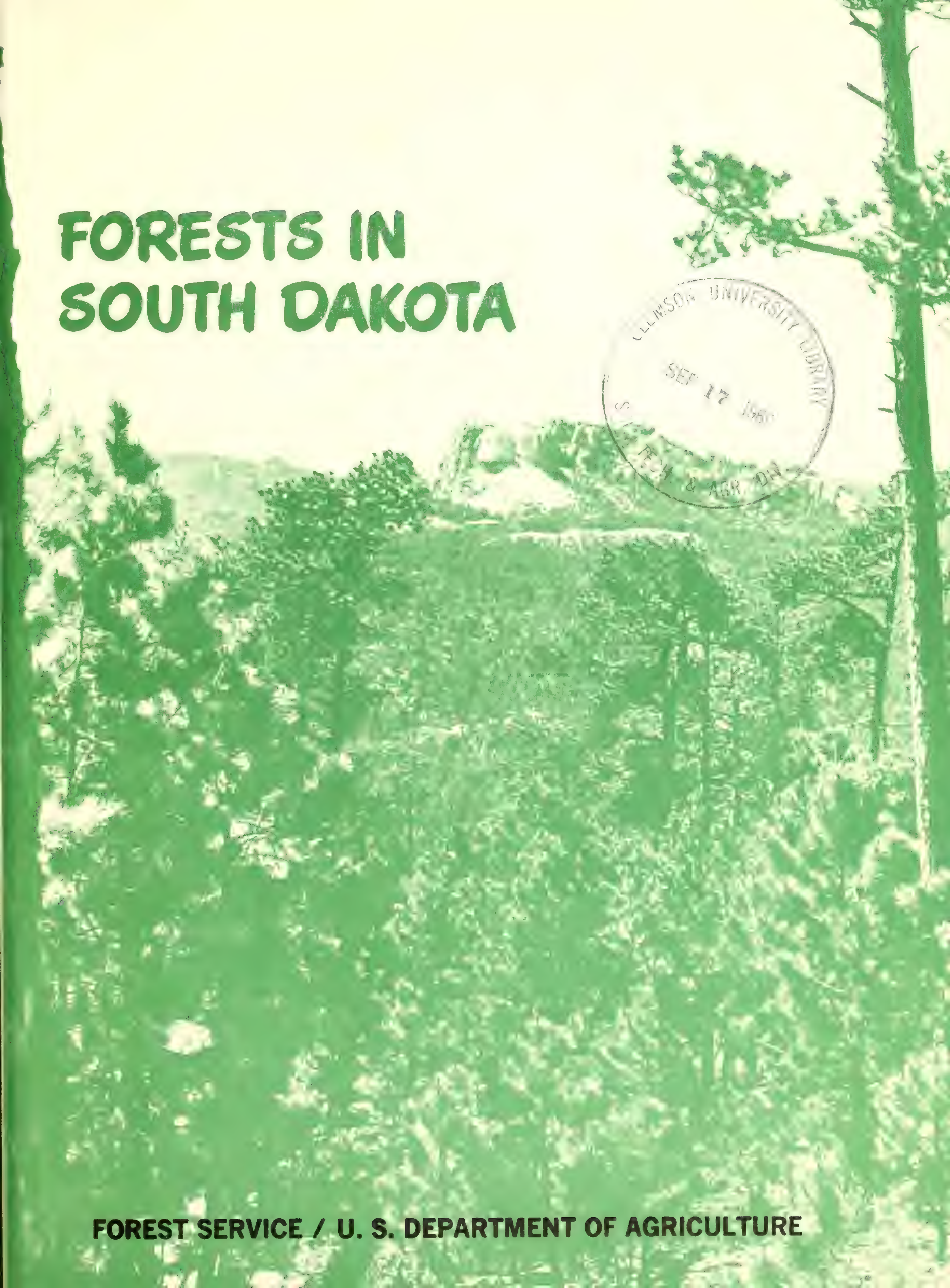

FORESTS IN SOUTH DAKOTA

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FRONT COVER

Dense stands of ponderosa pine shown here with Mount Rushmore in background are typical of forest stands in the Black Hills and are an essential element of the scenic attraction of this western South Dakota tourist mecca.

BACK COVER

Windbarrier plantings, such as shown here, account for thousands of acres planted with a wide variety of tree species in eastern South Dakota. These make very significant contributions to agriculture and enhance living conditions for farmers on the plains.

U. S. D. A. Forest Service
Resource Bulletin INT-8

1969

FORESTS IN SOUTH DAKOTA

By

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FOREST SERVICE / U. S. DEPARTMENT OF AGRICULTURE

Many of the statistics shown in this report are a composite of those already published separately for eastern and western South Dakota (Caporaso 1964; Spencer et al. 1964; Chase 1967).

Inventory data for western South Dakota[2] were collected during 1960 as a cooperative effort of the Rocky Mountain Region (Region 2) and the Intermountain Forest and Range Experiment Station. Data for eastern South Dakota were collected between December 1964 and April 1965 by the North Central Forest Experiment Station. A survey of timber removals, products output, and industries in western South Dakota for 1962 was made by the Intermountain Station, and in eastern South Dakota for 1964 by the North Central Station.

The Appendix to this report should be consulted for definitions of terms, survey methods and reliability of data, and detailed timber statistics. Next to the inside back cover is a generalized forest type map of South Dakota.

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[2] *Includes all of Harding, Butte, Lawrence, and Fall River Counties as well as all lands west of the 103d meridian in Meade, Pennington, and Custer Counties.*

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STATISTICAL HIGHLIGHTS

FOREST AREA

- The forest area covers 1.7 million acres, or 3.5 percent of South Dakota's land area.
- Commercial forests cover 1.5 million acres, or 89 percent of the forest area. The commercial forest area decreased 8 percent between 1935 and 1962.
- 72 percent of the commercial forest area is publicly owned. The U. S. D. A. Forest Service administers 62 percent of this area.
- 53 percent of the commercial forest area is in sawtimber stands; these stands average 3,840 board feet per acre.[3]
- The ponderosa pine type occupies 87 percent of the commercial area; the remainder is largely hardwood types.
- About 8 percent of the commercial forest area has a sustainable yield potential of more than 50 cubic feet per acre a year. The average annual potential for the total commercial forest area is 36 cubic feet per acre.

TIMBER VOLUME

- Commercial forests have 1.1 billion cubic feet of wood in all sound, live trees, and 3.7 billion board feet in sound, live trees of sawtimber size.
- Cubic-foot inventory increased about 50 percent between 1935 and 1962; sawtimber inventory remained about the same.
- 79 percent of the sawtimber volume is publicly owned.
- Seven-eighths of the sawtimber volume is ponderosa pine.

STAND CONDITIONS

- Mortality was low; only 7 percent of gross growth of growing stock and a slightly lower percentage of sawtimber growth were offset by mortality.
- Diseases accounted for 56 percent of the growing stock mortality during 1962.

TIMBER USE

- South Dakota's timber cut of 13.3 million cubic feet from growing stock in 1962 was 1.2 percent of inventory.
- 48 percent of the volume of roundwood products cut in 1962 was saw logs for lumber; 22 percent was pulpwood.
- During the period 1952-67, volume of timber harvested increased at an average rate of 3 percent per year.
- National Forest percentage of the total cut from growing stock in the State increased from 45 percent in 1935 to 82 percent in 1962.

---

[3] *International ¼-inch log rule board-foot volumes are used throughout this report unless otherwise stated.*

THE FOREST SITUATION TODAY

South Dakota's forest lands — 1.7 million acres comprising about 3.5 percent of the area of the State — are of increasing significance for timber, recreation, water, and other values. The economic and social benefits of these lands extend well beyond the borders of the State. About 1.5 million acres, or 89 percent of the forest land, are classed as commercially important for timber production. Products from timberlands — lumber, mine timber, poles, posts, and others — were originally marketed mainly in South Dakota and adjoining States; but many of these products as well as pulpwood now have moved to more distant markets in the Midwest. Recreation use of forest lands has increased very rapidly. State, federal, and private facilities have been pressed to meet mounting local and tourist demands for a wide variety of outdoor recreation opportunities. Water yields, particularly from the relatively high and heavily forested area of the Black Hills, are significant in this semiarid part of the country. Forest lands also provide important habitat for many wildlife species.

Nearly 200,000 acres of forest land are classed as noncommercial from the standpoint of timber yields. Ninety percent of this area is unproductive, either because site conditions are too poor to grow commercial crops of trees for industry, or because the forest type currently occupying the land is comprised of juniper, scrub hardwoods, or similar vegetation not of commercial importance for wood products at this time. The remaining 10 percent of the noncommercial area, although capable of growing commercial timber, is reserved for other use.

Commercial Forest Area

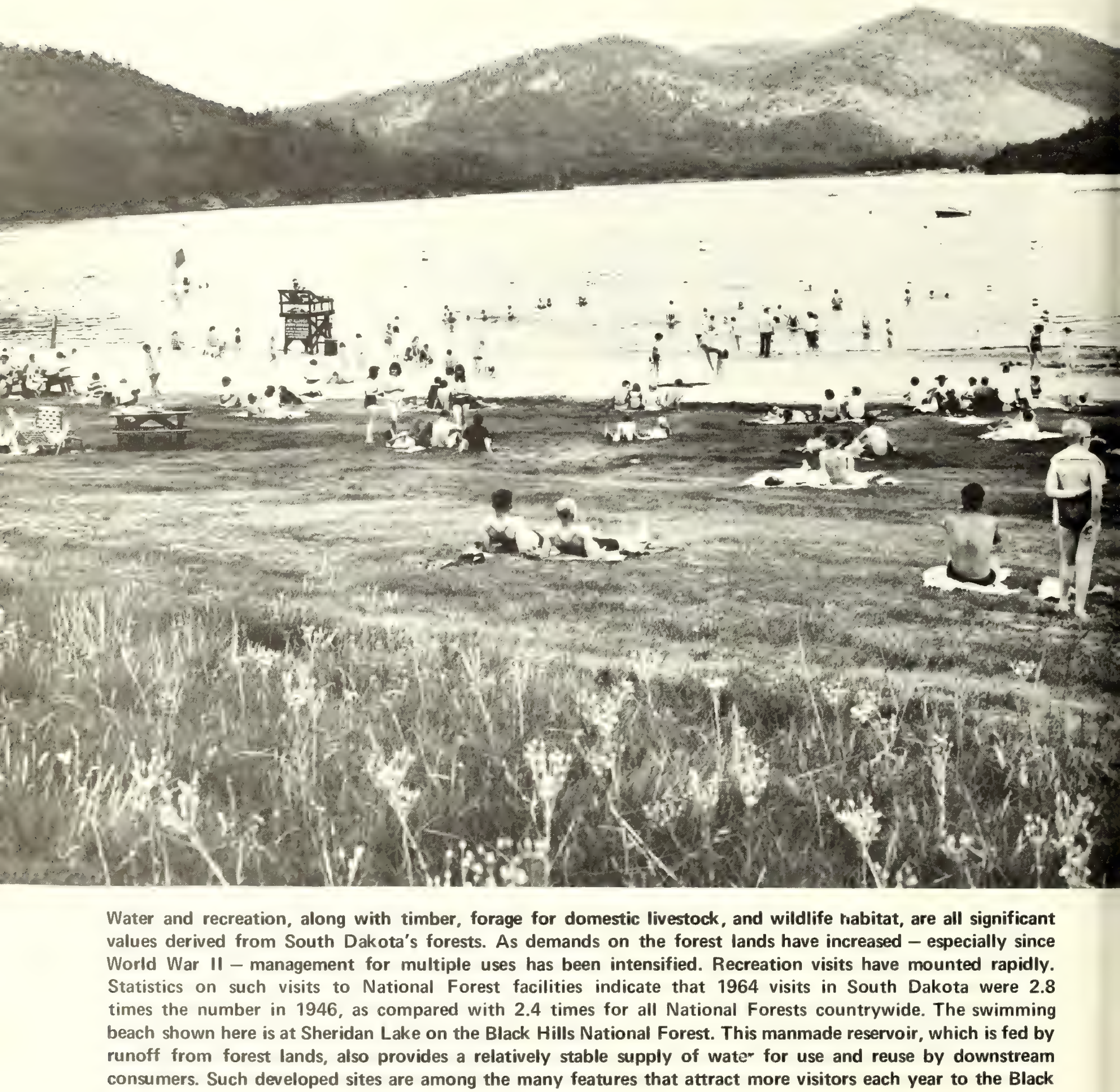
Forests in South Dakota represent a transition from hardwoods (broadleaf trees) of the plains in the east to the predominantly softwood (evergreen) forests of the Rocky Mountains to the west. The woodlands of the eastern part of the State (roughly east of Rapid City) consist mainly of natural stands of such native species as cottonwood, ash, elm, and oak. Some natural stands of hardwoods occur on upland sites, but are most common along streams, lakes, and reservoirs. Shelterbelt plantations of native and introduced species are also widely scattered throughout the rolling farmland areas of eastern South Dakota.

Ponderosa pine is by far the predominant species in the western part of the State. As a timber type it occupies 1,352,000 acres of which 1,330,000 acres is commercial forest. The latter figure represents about 87 percent of the State's commercial forest area. White spruce also occurs as a commercial timber type in western South Dakota although the area it occupies is very small — 23,000 acres.

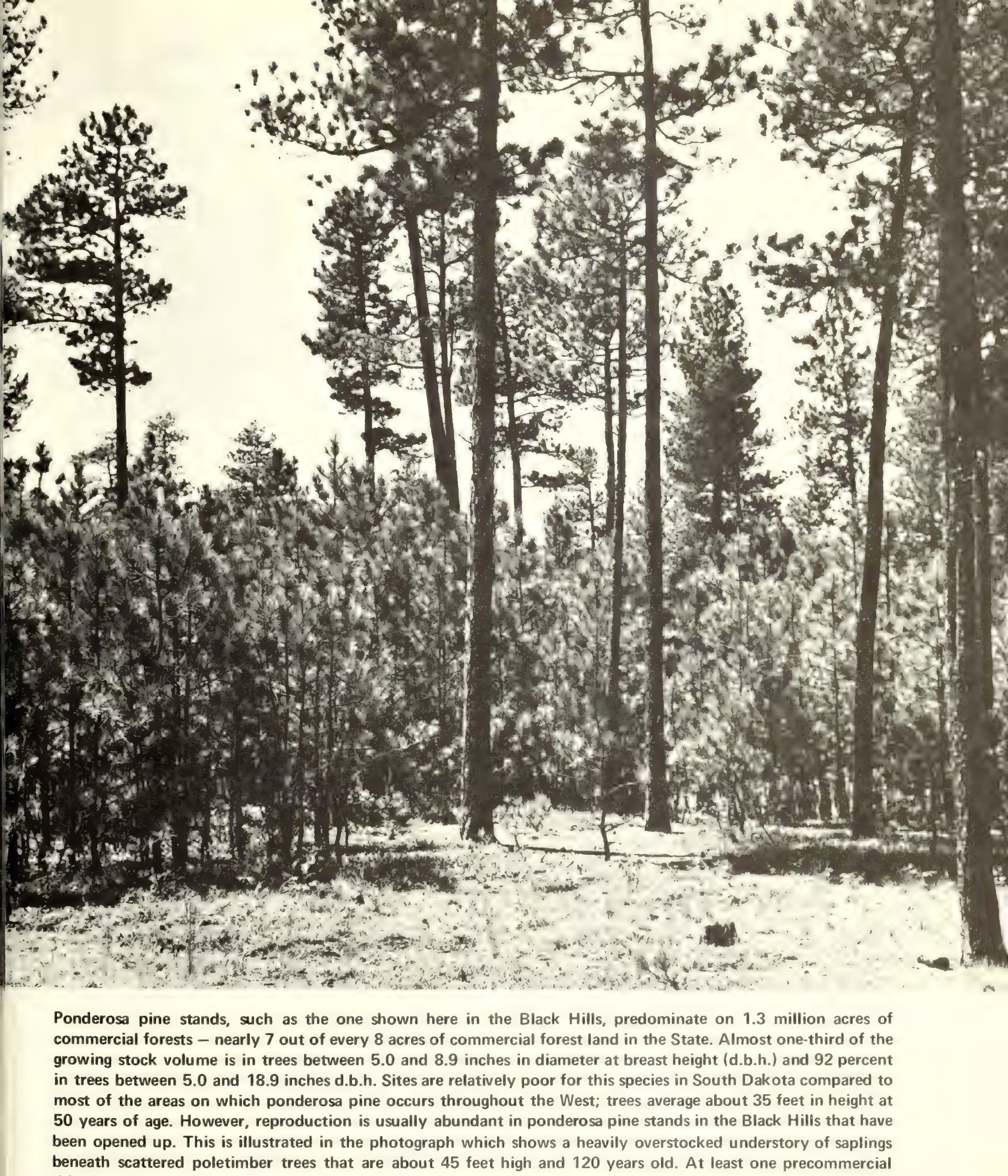
The Black Hills support the State's most significant commercial timber resource — extensive areas of ponderosa pine. The Black Hills lie within Lawrence, Meade, Pennington, Custer, and Fall River Counties, and these counties account for more than 85 percent of the commercial forest area of the State. This uplift area, where elevations range from about 3,200 to 7,242 feet above mean sea level, has the precipitation and other site conditions that permit the occurrence of ponderosa pine.

Few eastern South Dakota counties have more than 1 percent of their area in commercial forest. Union County in the southeastern corner of the State is the only one with more than 2 percent (see page 4).

Sawtimber stands occupy 813,000 acres and poletimber stands occupy 637,000 acres; combined they comprise 95 percent of the commercial forest area. A very small area (19,000 acres) is classed as nonstocked.

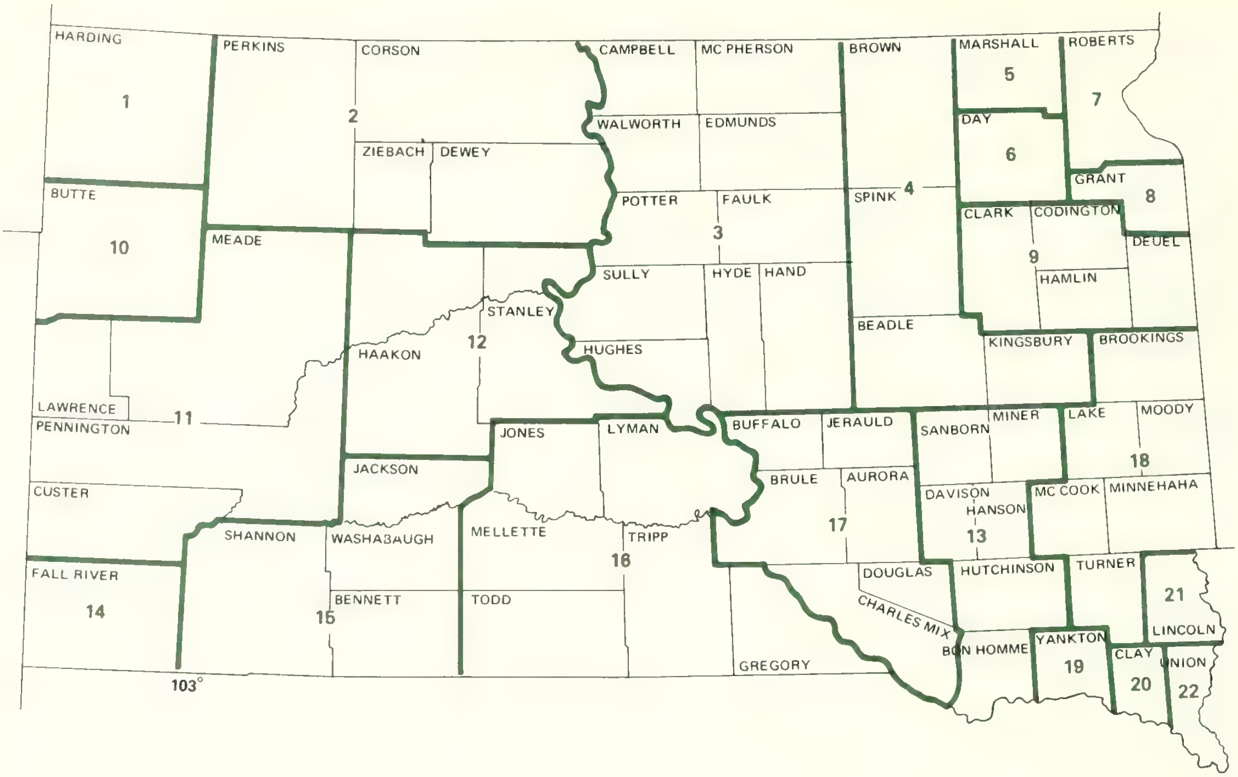


Water and recreation, along with timber, forage for domestic livestock, and wildlife habitat, are all significant values derived from South Dakota's forests. As demands on the forest lands have increased — especially since World War II — management for multiple uses has been intensified. Recreation visits have mounted rapidly. Statistics on such visits to National Forest facilities indicate that 1964 visits in South Dakota were 2.8 times the number in 1946, as compared with 2.4 times for all National Forests countrywide. The swimming beach shown here is at Sheridan Lake on the Black Hills National Forest. This manmade reservoir, which is fed by runoff from forest lands, also provides a relatively stable supply of water for use and reuse by downstream consumers. Such developed sites are among the many features that attract more visitors each year to the Black Hills National Forest than to any other National Forest in the country.



Ponderosa pine stands, such as the one shown here in the Black Hills, predominate on 1.3 million acres of commercial forests — nearly 7 out of every 8 acres of commercial forest land in the State. Almost one-third of the growing stock volume is in trees between 5.0 and 8.9 inches in diameter at breast height (d.b.h.) and 92 percent in trees between 5.0 and 18.9 inches d.b.h. Sites are relatively poor for this species in South Dakota compared to most of the areas on which ponderosa pine occurs throughout the West; trees average about 35 feet in height at 50 years of age. However, reproduction is usually abundant in ponderosa pine stands in the Black Hills that have been opened up. This is illustrated in the photograph which shows a heavily overstocked understory of saplings beneath scattered poletimber trees that are about 45 feet high and 120 years old. At least one precommercial thinning is desirable before trees reach merchantable size for posts or plywood.

Forest and Nonforest land areas by county groupings, 1962



No. on map	All land[1]	Nonforest land	Total forest land	Land Class	
				Commercial	Noncommercial
	Thousand acres				
1	1,717	1,701	16	15	1
2	5,225	5,205	20	14	6
3	6,265	6,249	16	10	6
4	3,368	3,355	13	10	3
5	560	554	6	5	1
6	678	675	3	3	([2])
7	711	695	16	13	3
8	438	433	5	4	1
9	1,807	1,801	6	5	1
10	1,441	1,429	12	5	7
11	5,499	4,179	1,320	1,235	85
12	3,142	3,129	13	10	3
13	2,166	2,154	12	9	3
14	1,114	1,011	103	76	27
15	3,300	3,233	67	45	22
16	5,090	5,036	54	36	18
17	2,615	2,607	8	5	3
18	2,495	2,475	20	16	4
19	333	328	5	4	1
20	258	254	4	3	1
21	369	365	4	3	1
22	291	281	10	8	2
Total	48,882	47,149	1,733	1,534	199

[1] *From Bureau of the Census, 1960.*

[2] *Less than 500 acres.*

The bulk of the commercial forest area is in public ownership:

	Percent
National Forest	63
Other federal	5
State	4
Private	28

There is considerable difference between softwood and hardwood areas with respect to ownership. Nearly four-fifths of the softwood area is publicly owned, the other one-fifth privately. In the case of hardwoods, the situation is reversed with four-fifths in private ownership.

About 99 percent of the 957,000 acres of commercial forest area in National Forest ownership is in the Black Hills National Forest, which straddles the Wyoming border. The remaining 1 percent is in the Custer National Forest in Harding County.

Timber Volume

Ninety-seven percent of the 1.12 billion cubic feet of timber on commercial forest lands is in growing stock trees; i.e., sound live trees 5 inches and larger in diameter at breast height (d.b.h.); the remainder is in rough, rotten, and salvable dead trees. However, the hardwood volume (0.1 billion cubic feet) has a substantial volume in defective trees — 26 percent.

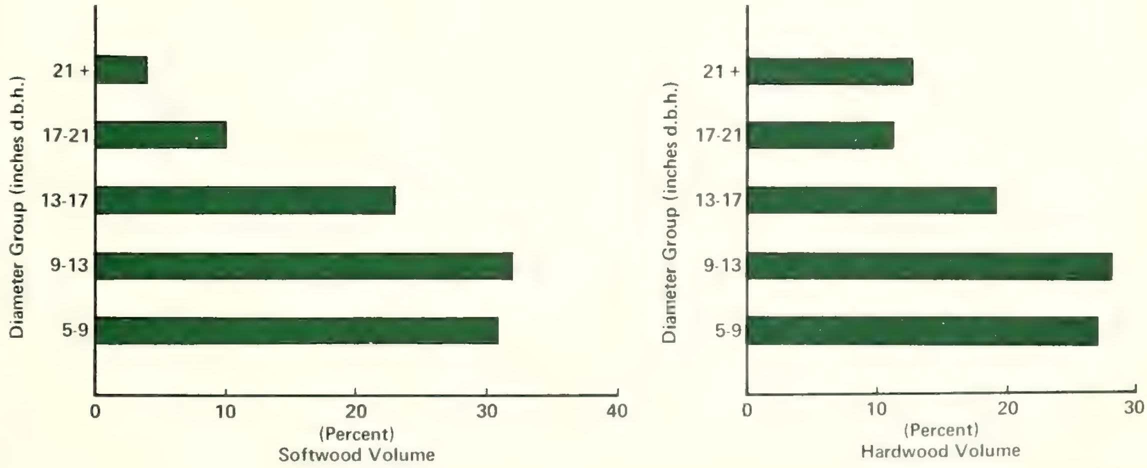
Growing stock volume is largely in trees of sawtimber size and of softwood species. A little more than two-thirds of this volume is in sawtimber trees. Distribution of growing stock volume by species is as follows:

	Million Cubic feet	*Percent*
Ponderosa pine	961	88.6
White spruce	46	4.2
Cottonwood	28	2.6
Ash	19	1.7
Elm	16	1.5
Other	15	1.4
	1,085	**100.0**

There are no important differences from the above in the distribution by species of the 3.7 billion board feet of sawtimber volume.

In comparison with averages for the Rocky Mountain States,[4] sawtimber trees are rela-

DISTRIBUTION OF CUBIC-FOOT VOLUME BY DIAMETER GROUPS



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[4] *The following are called Rocky Mountain or Mountain States in this report: Idaho, Montana, South Dakota (west of the 103d meridian), Wyoming, Colorado, Utah, Nevada, Arizona, and New Mexico.*

tively small in diameter in South Dakota and volumes per acre are low. Only 15 percent of the board-foot volume in South Dakota is in trees 19 inches d.b.h. and larger; this compares with nearly 40 percent for the Rocky Mountain area as a whole. Sawtimber volume per acre of commercial forest land in South Dakota is 2,422 board feet compared with an average of 6,276 board feet for the Mountain States and 4,985 for the United States. Sawtimber stands in South Dakota average 3,840 board feet per acre.

Distribution of growing stock of softwoods and hardwoods by tree diameter groups is illustrated by the chart on page 5.

The percentage of sawtimber volume among the four log grades used in the survey differs substantially between softwoods and hardwoods.[5] Only 2 percent of the softwood volume is in log grade 1; 83 percent is in grade 4. The majority (54 percent) of the hardwood volume is in grade 3 with the remainder fairly equally distributed among the other three grades.

The preponderance of timber volume is in National Forest ownership. The following percentage distribution by owners applies to both growing stock and sawtimber volume of all species combined:

	Percent
National Forest	**72**
Other public	**7**
Private	**21**

The distribution of softwood volumes is about the same as the above. However, more than 80 percent of the hardwood volume is privately owned, and only an insignificant amount is in National Forest ownership.

Growth and Mortality

In 1962 net annual growth amounted to 30 million cubic feet (including 103 million board feet sawtimber growth). These estimates represent the net increment after subtracting average annual mortality from gross growth. Mortality amounted to about 2 million cubic feet for growing stock and 6 million board feet for sawtimber. In 1962 diseases were responsible for 56 percent of the growing stock mortality.

Estimates of annual net growth of growing stock indicated above are about 2.9 percent greater than the average for the 10 years preceding the survey. Mortality estimates are 28 percent less. These differences arise in large measure from the fact that estimated mortality for 1962 in the eastern part of the State is the average of only 3 years — years during which rainfall was greater and growing conditions better than the 10-year average. Differences are less for sawtimber.

Normal mortality losses per acre are low in South Dakota in relation to much of the commercial forest area of the country. South Dakota's annual loss of 1.4 cubic feet per acre is less than one-tenth the average for the Mountain States and is about one-eighth that of the United States. Sawtimber losses are also low. There can be many reasons for this low mortality, and misleading conclusions can be drawn from comparisons such as indicated above unless all factors are known and considered. Nevertheless, there is little doubt that relatively intensive management and utilization of the major component of the forest (ponderosa pine) tends to minimize mortality. This in turn is a factor in the State's relatively high rate of net growth for growing stock — 2.8 percent.

Another reason for low normal mortality is that forest fires are not as extensive as in many other areas. Sampling on the latest inventory did not reveal any mortality by fire on commercial forest land — although fires have occurred every year. Over the period 1953-64 South Dakota had an average of 182 fires a year on all (commercial and noncommercial) forest lands. However, the average size of fires in South Dakota was 35 acres in comparison with about 45 acres for a 12-State area in the Rocky Mountains and Great Plains. The average for the United States (exclusive of Alaska and Hawaii) was also about 45 acres. During the same period, only 0.13 percent of the forest area in need of protection was burned in South Dakota; this compares with 0.19 percent for the 12-State area mentioned above and 0.83 percent for the United States.

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[5] *Different log grade standards are used for softwoods than for hardwoods; see Terminology in the Appendix.*

Timber Removals

Removals from growing stock in 1962 amounted to 13 million cubic feet (including 59 million board feet from sawtimber trees). Of these removals, 94 percent went into roundwood products (saw logs, pulpwood, fuelwood, poles, posts, etc.), and the remainder was mainly logging residues in the form of unused portions of trees cut or killed in logging. A small volume also resulted from thinnings, clearing for right-of-way construction, and changes in land use.

Distribution of removals from growing stock by ownership classes was as follows:

	Percent
National Forest	82
Other public	2
Private	16

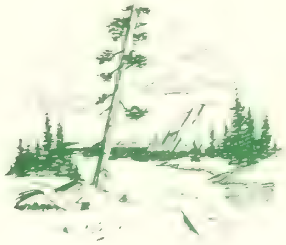
Volume cut from growing stock for timber products, together with logging residues, amounted to 1.2 percent of the 1.1 billion cubic feet of growing stock inventory. Although this is less than the average for the United States (1.6 percent), it is higher than the average for any of the individual Mountain States or the average of 0.7 percent for the Mountain States area (Wilson and Spencer 1967).

The total output of timber products from all forest lands in 1962 amounted to 14.5 million cubic feet.[6] About 95 percent of this was roundwood products, the remainder was pulp chips and other plant byproducts. A little more than 90 percent of the roundwood products came from growing stock trees, the remainder from rough, rotten, and dead trees on commercial forests and from trees on lands not classified as commercial forest.

Forty-two million board feet of logs for lumber and hardwood veneer and 41,000 cords of pulpwood made up more than 70 percent of the total products output. In cubic measure, the output by various products was as follows:

	Thousand cubic feet
Saw logs	6,658
Veneer logs	199
Pulpwood	3,564
Piling	10
Poles	570
Posts	833
Fuelwood	2,041
Other	605
All products	14,480

Except for pulpwood, which was all shipped to mills in the Lake States, the great majority of the volume of all other products was cut for wood processing plants located within South Dakota. About 7 million board feet of logs were shipped to Wyoming but this was more than offset by 8.5 million board feet brought in from Wyoming.



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[6] *Includes material removed from noncommercial as well as commercial forest land, and from nongrowing stock as well as growing stock. It also includes plant byproducts.*

The largest sawmill in South Dakota shown here is at Spearfish and is owned by the Homestake Mining Company; it has an annual capacity of about 17 million board feet. About one-half of the production is lumber; the remainder is mine timbers, snow fence lathe, and chips. The company's substantial timber holdings in the Black Hills are under forward-looking management for sustained yields.

TRENDS IN SUPPLY AND USE

The importance of South Dakota's forests as well as timber products to the State and other Midwest areas has resulted in many changes in the timber situation over the years. These changes appear particularly great in comparison with many other States in the midcontinent area, especially in relation to the Rocky Mountain area.

Although forest area has been somewhat reduced since 1935 because of impingement by other land uses, the supply situation has been greatly improved. Timber volumes, growth, and product harvest have all increased substantially over the last few decades. Most of this improvement results from more intensive protection and management of the State's major timber resource — the ponderosa pine lands. Establishment of the Black Hills National Forest in 1897 was a significant landmark in getting forests in this area under scientific management. In fact, the first regulated cutting on National Forests anywhere in the country began on the Black Hills National Forest a year after it was established. Now, with the holdings of the Homestake Mining Company and the State of South Dakota under management similar to that of the National Forests, essentially all the forests of the Black Hills are managed with the objective of a high level of sustained yield.

During the period 1935-62, the area of commercial forest dropped from 1,674,600 to 1,534,000 acres — a decrease of 140,600 acres.[7] This reduction occurred largely in eastern South Dakota because of flooding of wooded areas by reservoirs along the Missouri River and adjacent portions of tributaries. However, some reduction has occurred throughout the State because of changes in land use and right-of-way clearing.

Growing stock inventory increased from 720 million cubic feet in 1935 to 1,085 million cubic feet in 1962 — roughly 50 percent. Sawtimber inventory remained about the same. Decreases of 43 percent in both cubic- and board-foot volumes in the eastern part of the State were more than offset by increases in the western part of the State — particularly in cubic volume, which increased 77 percent. For the State, the volume of hardwood growing stock decreased nearly 50 percent while that of softwood increased 77 percent.

The flooding of timber areas not only caused substantial reduction in forest area, but it also was undoubtedly the major reason for the drop in timber volumes in the eastern part of the State.

Droughts since 1930 have also affected timberlands, particularly in the eastern part of the State. Although the 1950's were dry, the most severe period was the 1930's when average precipitation in 9 out of the 10 years was below the 18-inch annual average for the period 1930-62. Mortality, as a result of drought, was undoubtedly a factor in reducing inventory in eastern South Dakota, and in limiting the amount of net growth. However, despite the depressing effect of drought a substantial increase in net annual growth undoubtedly occurred. Reliable data are not available for the amount of net growth in 1935, but evidence suggests that net growth for the State in 1962 (30 million cubic feet) was in the neighborhood of 2.9 times the amount in 1935.

Although the volume of timber cut from growing stock in the course of harvesting only increased from 12 million cubic feet in 1935 to 13 million in 1962, significant changes have occurred within the timber industry. In 1935 only about 45 percent of the timber cut from growing stock came from National Forest lands; in 1962 it amounted to 82 percent. The product mix also changed to an important degree between 1935 and 1962. The following tabulation indicates the breakdown of cubic-foot volume of products from all sources for the 2 years.

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[7] *Estimates for 1935 used for comparisons in this report have been adjusted as much as possible in light of changes in inventory and utilization standards between inventories.*

1935[1]	*Percent*	*1962*	*Percent*
Saw logs	57.5	Saw logs[2]	47.4
Fuelwood	40.2	Fuelwood	14.1
Posts	2.3	Pulpwood	24.6
		Other	13.9

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[1] *Estimates of product volumes given in the 1936 report (Ware) are actually based on averages of annual estimates for the period 1924-34; it is assumed here that these averages can be used for 1935.*

[2] *Includes a small volume of hardwood veneer logs.*

Production of pulp chips from residues of saw log production has become a significant factor in pulpwood production. In 1962 pulp chips comprised about one-seventh of the pulpwood output. A decrease in the number of active sawmills, from 68 in 1935 to 29 in 1962, is another noteworthy change.

There are indications that both timber supply and use have increased since 1952. Statistics for 1962, as well as subsequent data on timber use, permit us to project data as a basis for determining current trends. These data indicate, for example, that between 1953 and 1968 the volume of growing stock has gone up 22 percent — from 0.96 to 1.17 billion cubic feet, even though the area of commercial forest land has decreased slightly (from 1.63 to 1.53 million acres). Sawtimber volume has increased 16 percent.

During the period 1952-67, timber removals fluctuated sharply within short periods. Substantial year-to-year changes are possible in practically all of the elements of removals — clearings for changes in land use, reservoir and right-of-way construction, timber cut for commercial use and catastrophic losses from fires and insects. However, removals of growing stock increased 21 percent during this period. The trend for timber harvesting alone was greater — about 54 percent, or from 8.9 million to 13.7 million cubic feet. This represents an average annual increase of nearly 3 percent. The increase since 1952 reflects much heavier cutting on National Forest lands, which contributed about 85 percent of the State's cut during this period. The trend in cut from other lands has been downward.

FUTURE OPPORTUNITIES

Although in some respects South Dakota's timberlands do not measure up to those in much of the rest of the country, this does not mean that there are not big opportunities to increase supply and use. The potential growth capacity of South Dakota's forests is relatively low — only about 8 percent of the commercial forest area has a potential of more than 50 cubic feet per acre per year. This compares with roughly 45 percent for the Mountain States and 77 percent for the United States. Despite this handicap, South Dakota has some of the most intensively used and managed forest land in the United States. The State is outstanding in the West in terms of the accessibility of its timber stands and in the high level of management that has been practiced for a long time in these stands. Proximity to midwest markets of forests that are predominantly of a desirable lumber species (ponderosa pine) is a primary reason for the State's long history of good management. Still, South Dakota is utilizing considerably less than one-third of its growth potential. Therefore, it seems perfectly realistic that forestry could be accelerated in the State and the contribution of timber to the economy greatly enhanced.

Preliminary estimates indicate that 16 million cubic feet were cut from commercial forest lands in 1966. This amounted to an average of 10.4 cubic feet per acre. Although the cut per acre from commercial lands on National Forests was somewhat higher — 13.7 cubic feet — it was still slightly less than half the cut the Forest Service considered technically allowable. In other words, the supply of National Forest timber, particularly small roundwood, was more than double the volume that could be marketed.

Considerable discretion is necessary in using comparisons of cut with growth. Such comparisons are not particularly useful until management and harvesting have resulted in a forest that has the age-class distribution, stocking, etc., necessary for a high level of sustained yields. Thus, while the fact that present cut is only 52 percent of growth is not particularly significant, the future relationship will be important. Growth in relation to cut must be considered in making projections and estimating potential yields. In fact, one of the assumptions used in this report to project growth, cut, and inventory to 1992 is that growth and cut of growing stock will be approximately equal at this time. On the basis of this and other assumptions,[8] projections (dash lines in chart below) indicate that by 1992 forests in the State will be yielding 40 million cubic feet from growing stock a year. Included in this is 138 million board feet of sawtimber. These yields would be equivalent to 26 cubic feet per acre including 91 board feet per acre.

Both growth and cut are expected to continue to rise beyond 1992, and the annual yield eventually could reach a level of at least 36 cubic feet per acre. This is the estimated potential from fully stocked natural stands. Yields could be higher than this if thinning and other intensive management practices are used.

The extent that timber yields increase in the years ahead depends on many factors that affect both supply and demand. Larger and more varied markets, vigorous programs of timber management and protection, and more detailed inventories are some of the important developments that are essential to minimizing the delay in realization of the State's timber potential. These factors are discussed briefly on the following pages.

Markets are a key consideration in future development. As indicated earlier, timber harvesting increased at an average annual rate of 3 percent between 1952 and 1967. Continuation at this level is essential for attaining projected yields on a sustainable basis by 1992.

A more diversified market is an important objective. Over the years, the saw log harvest for lumber has been the mainstay of South Dakota's timber economy. Although the annual harvest of saw logs is still increasing, the volume is a declining percentage of the total cut. As indicated by the chart on page 12, pulpwood and other products assumed much greater importance between 1952 and 1966. This is a significantly favorable trend. An increase in markets for small roundwood enhances opportunities to make commercial thinnings (which will accelerate growth of the remaining trees) and to utilize material that otherwise would be logging or sawmill residues.

Probably the greatest opportunities for diversifying and increasing the harvest of

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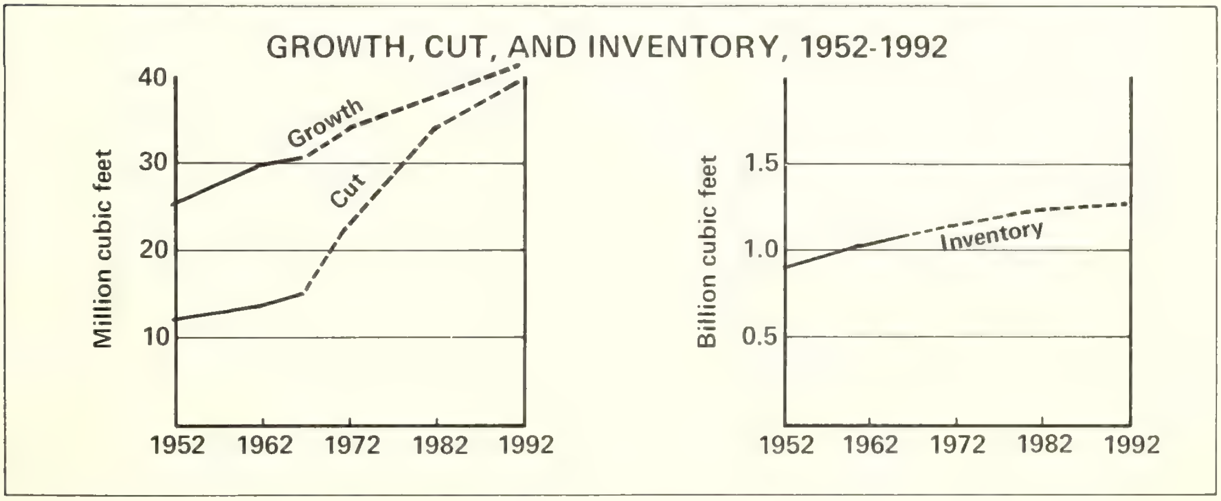
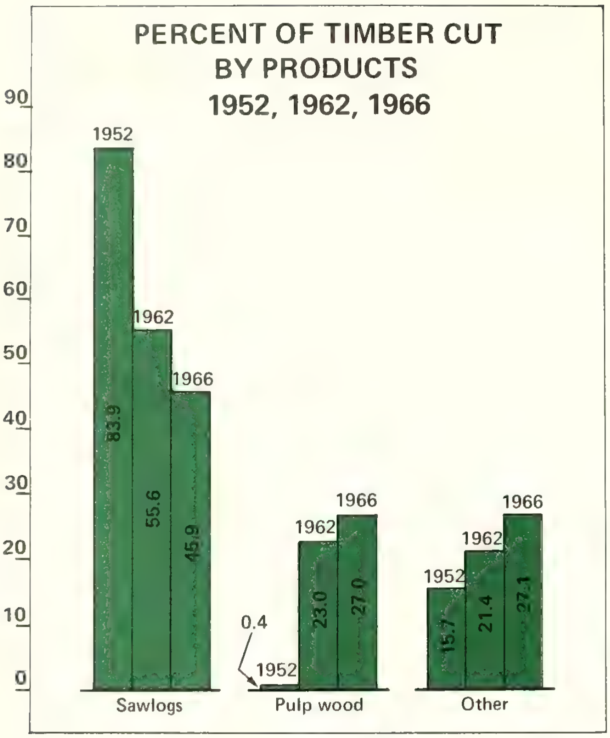
[8] *Assumptions used in projections are indicated as a footnote to Appendix table 28.*





products lie in pulpwood — and possibly veneer logs. The estimate of 54,000 cords of round pulpwood shipped to Lake States' mills in 1966 represents about 28 percent of the total output of roundwood. At least 3 times this volume could probably be harvested on a sustainable annual basis. In addition to roundwood, a substantial volume of pulp material is produced as a byproduct of sawmills — 0.8 million cubic feet (roughly 11,300 cords) of chips were shipped to Lake States' mills in 1966. Opportunities for increasing production of both roundwood and chips would be greatly enhanced if there were a closer pulpmill. The several studies that have been made of pulpwood supplies available in South Dakota and adjacent areas (Drake 1953; Fechner 1956; Chicago and Northwestern Railway Company 1964) indicate that the annual pulp harvest could be substantially greater than present harvests. However, these studies do not indicate that the combination of water and wood supplies is adequate for more than a small chemical mill — about 200 tons per day.

Veneer and plywood production offers another possibility for greater diversification of South Dakota's timber industry. Encouragement is lent to this possibility by the economic success in other parts of the country of peeling small logs similar to ponderosa pine logs harvested in the Black Hills. A study is currently being conducted by the Rocky Mountain Forest and Range Experiment Station to assess plywood production and marketing opportunities and related resource requirements.

Implicit in achieving an increasing timber harvest is intensified management. Management goals necessary to provide sustainable increasing yields include attainment of a better distribution of age classes of timber stands, more commercial thinnings to improve growth, and more effective protection by earlier removal of decadent and slow growing trees susceptible to insects and disease. Other requirements include prompt success in regeneration of cut or burned areas, as well as a larger program of precommercial thinning of overstocked stands. More intensive inventories on an acre-by-acre basis are necessary to determine stand conditions with respect to stocking, age, tree quality, etc., as well as to establish priorities of cutting or other management needs.

In new inventories in western South Dakota it is especially important to obtain more useful estimates of stand stocking than are presently available. As described in the Appendix, percentage of crown closure was used in the latest survey of western South Dakota as a measure of stocking. Estimates of stocking by this technique are not sufficiently indicative of thinning and other management treatments needed to meet current objectives with respect to tree growth and product yields. Usually, stands with complete crown closure (100 percent stocked by the crown-closure criterion) have substantially more trees per acre than desirable under good management.

Considerable differences exist among the many owners of commercial forest land with respect to technical competence and economic judgment necessary to maximize timber yields on a sustainable basis. Owners

Ponderosa pine pulpwood is shown being loaded here for rail shipment. About 54,000 cords of roundwood and 11,300 cords of chips from sawmill residues were produced in South Dakota in 1966; the entire volume was shipped to mills in the Lake States. Commercial thinnings in ponderosa pine provide small roundwood suitable for posts as well as pulp.

A mechanical tree planter is shown being used to plant ponderosa pine seedlings on the Black Hills National Forest. Tree planting and seeding for timber production, and planting for windbarriers continue to be important programs in South Dakota. In 1966, for example, 11,422 acres were planted or seeded — almost 80 percent for windbarriers, the remainder for timber production. Planting and seeding for timber production was done mainly on National Forest lands, whereas about 80 percent of the windbarrier planting was done on private holdings. Artificial reforestation on National Forest lands is usually limited to burned areas where the seed source has been destroyed. Most of the remaining plantable area must be cleared of brush and aspen.

Precommercial thinning of ponderosa pine such as shown at left is a common practice on the Black Hills National Forest. Gasoline-powered saws are being used by this crew. During the period 1963-67, an average of nearly 5,800 acres a year was thinned on National Forest lands in South Dakota.

of large holdings — public and private — have this competence. However, this is not true of most small private owners. Private ownership of commercial forest land amounts to 430,000 acres, or about 28 percent of the commercial forest land in the State. Of the privately owned lands, 86 percent or 368,000 acres are in the hands of farmers. Considerable technical aid has been provided small owners in the past, particularly in shelterbelt planting and utilization practices. Although some small owners do not consider timber production a primary objective in managing their forest land, many would like to substantially increase yields. What assistance is available for these owners?

Small owners can seek help from a number of sources — both private and public. Services of consulting foresters are available. Another private source is American Forest Products Industries, Inc., which offers technical advice as part of its tree farm program. In mid-1968, this organization listed 265 tree farms embracing 45,069 acres in South Dakota. Sources of public assistance include the office of the South Dakota State Forester, the Rocky Mountain Region of the Forest Service, and the Soil Conservation Service. The State Forester and U. S. D. A. Forest Service recently expanded their services by adding utilization and marketing specialists to their staffs.

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APPENDIX

TERMINOLOGY[10]

Land and Forest Area

Land area. — Dry land and land temporarily or partially covered by water, such as marshes, swamps, and river flood plains; streams, sloughs, estuaries, and canals less than one-eighth of a statute mile in width; and lakes, reservoirs, and ponds less than 40 acres in area. These figures are from the U. S. Bureau of the Census, Water Area of the United States, 1960.

Forest land. — Land at least 10 percent stocked by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest use. Includes afforested areas and roadside, streamside, and shelterbelt strips of timber that have a crown width of at least 120 feet. Unimproved roads and trails, streams, and clearings within forest areas classed as forest are included if less than 120 feet in width.

Commercial forest land. — Forest land that is producing or is capable of producing crops of industrial wood and that is not withdrawn from timber utilization by statute or administrative regulation. Includes areas suitable for management to grow crops of industrial wood; such areas generally have a site quality capable of producing in excess of 20 cubic feet per acre of annual growth. This includes both accessible and inaccessible areas and both operable as well as currently inoperable areas.

Noncommercial forest land. — Unproductive forest land incapable of yielding crops of industrial wood because of adverse site conditions, and productive forest land withdrawn from commercial timber use through statute or administrative regulation.

Nonforest land. — Land that has never supported forests and lands formerly forested where forest use is precluded by development for "nonforest" uses, such as crops, improved pasture, residential areas, and city parks. Also includes improved roads and adjoining right-of-way, powerline clearings, and certain areas of water classified by the U. S. Bureau of Census as land. Includes unimproved roads, streams, canals, and nonforest strips in forest areas that are more than 120 feet wide.

Ownership Classes

National Forest lands. — Federal lands that have been designated by Executive Order or statute as National Forests.

Other federal lands. — Federal lands other than National Forests, including lands administered by the U. S. Bureau of Land Management, National Park Service, and other federal agencies. This includes lands held or managed for Indians.

State lands. — Lands owned by State or leased for more than 50 years.

Farmer-owned lands. — Lands owned by operators of farms. A farm is defined as a unit of 10 or more acres from which the sale of agricultural products totaled $50 or more annually, or a place operated as a unit of less than 10 acres from which the sale of agricultural products totaled $250 or more during the previous year.

Miscellaneous private lands. — Privately owned lands other than farmer-owned.

Forest Types

Forest land is classified into types on the basis of tree species: the type name is that of the predominant species, or group of species. Predominancy of species is based on somewhat different standards in western and eastern South Dakota. In both parts of the State, cull trees as well as growing stock trees were included: (1) in western South Dakota, the predominant species is the one that has a plurality of gross cubic volume in the case of poletimber and sawtimber stands, or number of stems in sapling and seedling stands; (2) in eastern South Dakota, the predominant species is based on majority of stocking (see Stocking). Following are types that occur in the State:

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[10] *Definitions of some terms changed between the time of the survey of western South Dakota (1960) and that of eastern South Dakota (1965). Both definitions are shown for items where changes were most significant.*

Ponderosa pine. — Ponderosa pine predominates.

Oak-hickory. — This is a general type. In South Dakota, this type may be broken down into two subtypes on the basis of predominance of one or more of several species:

a. *Oak-hickory.* — Upland oaks predominate.

b. *Elm-ash-locust.* — Upland growing elm or ash, singly or in combination, predominate.

Elm-ash-cottonwood. — This is a general type. In South Dakota, this type may be broken down into four subtypes on the basis of predominance of species and topographic location (upland or lowland).

a. *Elm-ash-cottonwood.* — Predominant species are elm, ash, cottonwood, and willow, usually in combination, with occurrence on lowland sites.

b. *Cottonwood.* — Cottonwood predominates.

c. *Willow.* — Willow predominates.

d. *Lowland plains hardwoods.* — Black walnut, hackberry, bur oak, and boxelder predominate (either singly or in combination). These occur in coves or bottom lands.

White spruce. — White spruce predominates.

Pinyon-juniper. — Juniper predominates. This type is always classed as noncommercial forest.

Chaparral. — Brush and scrub hardwoods predominate; the crown canopy at maturity covers more than 50 percent of the ground. This type is always classed as noncommercial forest.

Stocking

Stocking is a measure of the degree to which growing space is effectively utilized by live trees. In the inventory of western South Dakota, stocking was determined from aerial photographs and rated on the basis of the percentage of available space occupied by tree crowns.[11] In the inventory of eastern South Dakota, stocking was rated on the basis of field measurements of number, size, and spacing of trees. When related to a stocking standard corresponding to full utilization of the growth potential of the land, these indicated the degree or percentage of stocking.

Stands have been classified as follows:

Well-stocked stands (70 percent or more stocked); medium-stocked stands (40 to 70 percent stocked); poorly stocked stands (10 to 40 percent stocked); and nonstocked area (less than 10 percent stocked).

Stand-size Classes

Sawtimber stands. — Stands at least 10 percent stocked with growing stock trees having (1) in western South Dakota, a minimum net volume per acre of 1,500 board feet (International ¼-inch rule) in sawtimber trees; (2) in eastern South Dakota, one-half or more of the total stocking in sawtimber and poletimber trees and with sawtimber stocking at least equal to poletimber stocking.

Old-growth sawtimber. — A sawtimber stand in which the majority of the net board-foot volume is in sawtimber trees 21.0 inches d.b.h. and larger.

Young-growth sawtimber. — A sawtimber stand in which the majority of the net board-foot volume is in sawtimber trees less than 20.9 inches d.b.h.

Poletimber stands. — Stands that (1) are at least 10 percent stocked with growing stock trees; (2) fail to meet sawtimber stand specifications; and (3) have at least one-half the total stocking in poletimber and larger trees and with poletimber stocking exceeding that of sawtimber.

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[11] *Although used to rate stocking in western South Dakota, percentage of available space occupied by tree crowns is not generally considered a reliable indication of the need for thinning and other management measures.*

Sapling-seedling stands. — Stands that (1) are at least 10 percent stocked with growing stock trees; (2) fail to meet sawtimber or poletimber stand specifications; and (3) have more than one-half of the total stocking in sapling and/or seedlings.

Nonstocked stands. — Commercial forest land less than 10 percent stocked with growing stock trees.

Site Classes

A classification of forest land in terms of inherent capacity to grow crops of industrial wood in fully stocked natural stands.

Tree Classification

Growing stock trees. — Sawtimber trees, poletimber trees, saplings and seedlings; i.e., all live trees except rough and rotten trees.

Sawtimber trees. — Live trees of commercial species containing at least one log (10-foot in western South Dakota and 12-foot in eastern South Dakota). Softwoods must be at least 9.0 inches d.b.h. and hardwoods at least 11.0 inches d.b.h. Maximum permissible cull is two-thirds of the board-foot volume.

Poletimber trees. — Live trees of commercial species at least 5.0 inches d.b.h. but smaller than sawtimber size and of good form and vigor.

Sapling and seedling trees. — Live trees of commercial species less than 5.0 inches d.b.h. and having form and quality to qualify as potential poletimber trees.

Rotten trees. — Live trees of commercial species that will not now or in the future qualify as sawtimber trees because of dimensions — diameter and minimum size specifications for saw logs and/or will not meet sawtimber tree requirements because of excessive defect, primarily due to rot; i.e., when more than 50 percent of the cull volume is attributable to rot.

Rough trees. — Live trees of (1) commercial species that will not now or in the future qualify as sawtimber trees because of dimensions — diameter and minimum size specifications for saw logs and/or will not meet sawtimber tree requirements because of excessive defect, primarily due to roughness or poor form; and (2) noncommercial species.

Timber Volumes

Growing stock volume. — Net cubic-foot volume of sawtimber trees and poletimber trees above 1-foot stump to a minimum 4.0-inch top (outside bark) or to the point where the central stem breaks into limbs.

Sawtimber volume. — Net volume in board feet (International ¼-inch rule) of the saw log portion of live sawtimber trees. The volume of sawtimber is included in the volume of growing stock.

Saw log portion. — That portion of the bole of sawtimber trees between the stump and the merchantable top. The latter varies from 5 to 10 inches inside bark depending on d.b.h. and whether trees are softwoods or hardwoods.

Upper stem portion. — That portion of the bole of sawtimber trees above the merchantable top to a minimum top diameter of 4.0 inches (outside bark) or to the point where the central stem breaks into limbs.

Log grade. — Sawtimber volume is classified as to quality on the basis of log grades. The grades are defined by external log features, principally by the occurrence and characteristics of knots. Hardwoods are classified into four grades in accordance with "Hardwood Log Grade for Standard Lumber" issued by the Forest Products Laboratory under the designation D1737 in 1953 and standards for hardwood tie and timber logs. Softwood logs are classified into four grades, which are defined as follows:

> *Grade 1 (select logs)* are essentially smooth and surface clear, except that in logs 16 inches and larger in diameter a few visible knots are permitted, provided there are no more than one large knot, or two medium or small knots, or four pin knots.

Knot sizes for all grades are:

Pin knots (0.5 inch or less)

Small knots (0.5 to 0.75 inch)

Medium knots (0.75 to 1.5 inches)

Large knots (Larger than 1.5 inches)

Occasional logs having a greater number of knots are admitted provided these knots may be boxed in an area not exceeding one-third the area of one face or an equivalent area of two faces.

Grade 2 (shop logs) display relatively few knots of any size, which are so spaced that at least 50 percent of the surface of the log is in smooth, clear areas, the size of which must be at least one-fourth the girth of the log in width by 4 feet or more in length.

A log with no more than 12 medium or smaller knots, or more than eight large ones, may immediately be classed as grade 2. If this number of knots is exceeded, the clear area basis governs.

Grade 3 (common logs) display either (a) pin, small, or medium knots of which 80 percent are either live or will cut out red (intergrown) beneath the slab, or (2) 16 dead knots (an average of four per face) averaging medium in size.

Grade 4 (low common logs) display medium, large, and very large live and/or dead knots in excess of the numbers permitted in grades 2 and 3.

Growth and Mortality

Net annual growth of sawtimber or growing stock. — The annual change in board-foot volume of sawtimber and of cubic-foot volume of sawtimber and poletimber combined. Net annual growth is the resultant of increment in net volume on trees that survived through the period over which annual growth was averaged, plus the ingrowth volume, minus the volume of trees that either died or became cull during the period.

Mortality of sawtimber or growing stock. — The net board-foot volume of sound wood in live sawtimber trees and net cubic-foot volume of sawtimber and poletimber trees combined that die annually from natural causes. These causes include fire, insects, disease, other, and unknown. The "other" category includes death due to animals (other than man), weather, and suppression. Death caused by logging or other activities of man is not included.

Removals

Total removals from growing stock and sawtimber. — The net cubic-foot and board-foot volume in growing stock and sawtimber trees, respectively, that was removed from the inventory by harvesting including logging residues; by cultural operations, such as timber stand improvement, land clearing; or by changes in land use.

Timber products. — Roundwood products and plant byproducts. Roundwood products include material cut from growing stock on commercial forest land; from other sources, such as cull trees, salvable dead trees, limbs, and saplings; and from trees on noncommercial and nonforest lands.

Roundwood products. — Logs, poles, posts, bolts, or other round sections cut from trees for industrial or consumer uses.

Logging residues. — The unused portions of trees cut or killed by logging.

Plant byproducts. — Wood products, such as pulp chips and lathe, obtained incidental to manufacture of primary products.

Plant residues. — Wood materials from manufacturing plants not utilized for some product. Includes slabs, edgings, trimmings, miscuts, sawdust, and shavings.

Tree Species

The following includes both the principal species as well as some that are uncommon. Not all species were encountered on inventory sample plots.

Softwoods

Ponderosa pine	*Pinus ponderosa*
Redcedar	*Juniperus virginiana*
Western juniper	*J. occidentalis*
White spruce	*Picea glauca* var. *densata*

Hardwoods

Select white oaks	
Bur oak	*Quercus macrocarpa*
Chinkapin oak	*Q. muehlenbergii*
White oak	*Q. alba*
Select red oaks	
Northern red oak	*Quercus rubra*
Shumard oak	*Q. Shumardii*
Other white oaks	
Post oak	*Quercus stellata* var. *stellata*
Other red oaks	
Black oak	*Quercus velutina*
Pin oak	*Q. palustris*
Shingle oak	*Q. imbricaria*
Hickory	
Bitternut hickory	*Carya cordiformis*
Mockernut hickory	*C. tomentosa*
Pecan	*C. illinoensis*
Pignut hickory	*C. glabra*
Shagbark hickory	*C. ovata*
Shellbark hickory	*C. laciniosa*
Hard maple	
Black maple	*Acer nigrum*
Sugar maple	*A. saccharum*
Soft maple	
Boxelder	*Acer negundo*
Red maple	*A. rubrum* var. *rubrum*
Silver maple	*A. saccharinum*
Ash	
Green ash	*Fraxinus pennsylvanica*
Cottonwood	*Populus deltoides*
Basswood	
American basswood	*Tilia americana*
Black walnut	*Jaglans nigra*
Other eastern hardwoods	
American elm	*Ulmus americana*
Rock elm	*U. thomasii*
Siberian elm	*U. pumila*
Slippery elm	*U. rubra*
Hackberry	*Celtis occidentalis*
Sycamore	*Platanus occidentalis*
Black willow	*Salix nigra*
Black cherry	*Prunus serotina*
Other soft hardwoods	
Kentucky coffeetree	*Gymnocladus dioicus*
Northern catalpa	*Catalpa speciosa*
Ohio buckeye	*Aesculus glabra*
Quaking aspen	*Populus tremuloides*
Red mulberry	*Morus rubra*
River birch	*Betula nigra*
White mulberry	*Morus alba*
Other hard hardwoods	
Black locust	*Robinia pseudoacacia*
Common persimmon	*Diospyros virginiana*
Flowering dogwood	*Cornus florida*
Honey locust	*Gleditsia triacanthos*

SURVEY METHODS AND RELIABILITY OF DATA

Interpretation of aerial photographs, together with sample measurements of trees on the ground, provided the principal source of statistics on acreage, volume, growth, and mortality in South Dakota. Although this general approach was used throughout the State, the evolution in many techniques between the time of the western South Dakota inventory (1960) and that of the eastern portion of the State (1965) resulted in certain significant differences in detailed methods.

Even within western South Dakota, methods varied. All lands were type-mapped within the boundaries of the Black Hills National Forest by the use of aerial photographs. These maps provided a basis for estimating acreage by ownerships, land classes, forest types, etc. Trees were measured and classified on 137 locations on National Forest lands within the Black Hills National Forest. These locations, which had originally been established in 1953-54, were remeasured to estimate volume, growth, and mortality. Each location consisted of a cluster of from one to four rectangular plots within each of which sample size varied with size and type of trees; sawtimber trees for example were measured on a 1/5-acre area. Standard measurements and classifications were made of tree diameters, heights, species, etc.

Lands in western South Dakota outside the Black Hills National Forest were not mapped but were sampled using a systematic grid of points on aerial photographs to estimate acreages. A large number of points was examined to classify forest and nonforest lands and to distinguish commercial forest from noncommercial forest. The 874 points classified as commercial forest were further interpreted for timber type, stand-size class, etc. From these 874 points, 30 were selected at random as locations for field measurements. These 30 locations were established and measured in the same manner as those on the Black Hills National Forest.

Eastern South Dakota was sampled on photos using 323,141 well-distributed points. A subsample proportional to area represented by these points was checked at 217 forest and 80,336 nonforest locations. On each of the 217 forest locations, detailed tree measurements and classifications were made within a 1-acre area.

Estimates of timber removals are based on various sources of information. Volumes of timber products and mill residues were obtained from canvasses of almost all wood processing plants. These canvasses provided 1962 information for western South Dakota and 1964 information for eastern South Dakota. Other removals resulting from changes in land use, thinnings, etc., could not be determined by surveys, but were estimated on the basis of the best available information.

Forest resource statistics are subject to both human and sampling errors. The amount of human error cannot be measured, but is minimized through close supervision and adequate training of employees, and through rechecking of all phases of the work. Sampling errors are subject to the laws of chance and may be estimated by statistical methods. These errors are held to acceptable levels by adjusting the survey design and sample size. Chances are two out of three that the actual area of commercial forest is within ±1.16 percent of the estimated area (1,533,900 acres). Included in this estimated area are the 1,098,000 acres within the boundaries of the Black Hills National Forest which, because it was completely mapped, is considered free of sampling error.

The sampling error for growing stock volume (1,085 million cubic feet) is estimated at ±5.19 percent, and for timber cut during harvest (13,289,000 cubic feet) at ±3.2 percent.

TIMBER STATISTICS

Table 1.--Area by land classes, South Dakota, 1962

Land class	Thousand acres
Forest land:	
Commercial	1,534
Productive reserved	19
Unproductive	180
Total forest	1,733
Nonforest land:	
Cropland[1]	17,424
Pasture and range	26,584
Other[2]	3,141
Total nonforest	47,149
Total area[3]	48,882

[1] Source: 1959 Census of Agriculture.

[2] Includes swampland, industrial urban areas, other nonforest land, and land (366,000 acres) classed as water by Forest Survey standards, but defined by the U.S. Bureau of Census as land.

[3] Source: U.S. Bureau of the Census, Land and Water Area of the United States, 1960.

Table 2.--Area of commercial forest land, by ownership classes, South Dakota, 1962

Ownership class	Thousand acres
National Forest	957
Other Federal:	
Bureau of Land Management	7
Indian	66
Miscellaneous Federal	9
Total other Federal	82
State	65
County and municipal	--
Forest industry[1]	--
Farmer-owned	368
Miscellaneous private:	62
Individual[2]	--
Corporate[2]	--
Total miscellaneous private	62
All ownerships	1,534

[1] Forest industry has been combined with miscellaneous private to avoid disclosure of holdings of an individual owner.

[2] Not available.

Table 3.--Area of commercial forest land, by stand size and ownership classes, South Dakota, 1962

(Thousand acres)

Stand size class	All ownerships	National Forest	Other public	Forest industry[1]	Farmer and miscellaneous private
Sawtimber stands:[2]					
Old growth	(3/)	--	--	--	(3/)
Young growth	813	569	70	--	174
Total sawtimber	813	569	70	--	174
Poletimber stands	637	343	71	--	223
Sapling and seedling stands	65	33	6	--	26
Nonstocked areas	19	12	(3/)	--	7
All classes	1,534	957	147	--	430

---

[1] Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

[2] Breakdown by old and young growth required only in the West; all sawtimber stands in the East are included in young growth.

[3] Less than 0.5 thousand acres.

Table 4.--Area of commercial forest land, by stand-volume and ownership classes, South Dakota, 1962

(Thousand acres)

Stand volume per acre[1]	All ownerships	National Forest	Other public	Forest industry[2]	Farmer and miscellaneous private
Less than 1,500 board feet	751	387	86	--	278
1,500 to 5,000 board feet	714	511	61	--	142
More than 5,000 board feet	69	59	--	--	10
All classes	1,534	957	147	--	430

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[1] International ¼-inch rule.

[2] Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 5.--Area of commercial forest land, by stocking classes of all live trees, and by stand-size classes, South Dakota, 1962

(Thousand acres)

Stocking class	All stands	Sawtimber stands	Poletimber stands	Sapling and seedling stands	Non-stocked stands
70 percent or more	220	127	86	7	--
40 to 70 percent	1,080	602	452	26	--
10 to 40 percent	215	84	99	32	--
Less than 10 percent	19	--	--	--	19
All classes	1,534	813	637	65	19

Table 6.--Area of commercial forest land, by site and ownership classes, South Dakota, 1962

(Thousand acres)

Site class	All ownerships	National Forest	Other public	Forest industry[1]	Farmer and miscellaneous private
50 to 85 cu. ft.	116	63	12	--	41
20 to 50 cu. ft.	1,418	894	135	--	389
All classes	1,534	957	147	--	430

---

[1] Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 7.--Area of commercial forest land, by forest types and ownership classes, South Dakota, 1962

(Thousand acres)

Forest type	All ownerships	Public ownerships	Private ownerships
Softwoods:			
Ponderosa pine	1,330	1,047	283
White spruce	23	21	2
Total softwood types	1,353	1,068	285
Hardwoods:			
Oak-hickory	8	4	4
Elm-ash-locust	36	2	34
Willow	7	1	6
Lowland plains hardwoods	23	2	21
Elm-ash-cottonwood	64	21	43
Cottonwood	43	6	37
Total hardwood types	181	36	145
All types	1,534	1,104	430

Table 8.--Area of noncommercial forest land, by forest types, South Dakota, 1962

(Thousand acres)

Type	All areas	Productive reserved areas	Unproductive areas
Ponderosa pine	22	19	3
White spruce	(1/)	(1/)	--
Lowland plains mixed hardwoods	6	--	6
Elm-ash-cottonwood	20	--	20
Cottonwood	3	--	3
Other hardwoods (unclassified)	71	--	71
Chaparral	3	--	3
Pinyon-juniper	74	--	74
All types	199	19	180

1/ Less than 0.5 thousand acres.

Table 9.--Number of growing stock trees on commercial forest land, by species and diameter classes, South Dakota, 1962

(Thousand trees)

Species	Diameter class (inches at breast height)												
	All classes	1.0-2.9	3.0-4.9	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0 and larger
Softwoods:													
Ponderosa pine	502,906	217,592	98,980	86,438	49,134	22,957	13,357	7,582	3,649	1,784	919	512	2
White spruce	8,528	2,020	1,837	1,864	1,018	443	428	424	219	96	87	92	--
Cedar	42	42	--	--	--	--	--	--	--	--	--	--	--
Total softwoods	511,476	219,654	100,817	88,302	50,152	23,400	13,785	8,006	3,868	1,880	1,006	604	2
Hardwoods:													
Bur oak	1,772	151	462	536	336	137	108	26	10	3	3	--	--
Hard maple	82	--	--	67	--	15	--	--	--	--	--	--	--
Ash	8,312	2,208	1,896	2,320	767	502	297	207	74	20	12	9	--
Black Walnut	131	126	--	--	--	--	--	--	--	--	3	2	--
Elm	3,801	625	598	983	566	292	301	202	99	48	32	44	11
Hackberry	347	15	210	61	38	17	6	--	--	--	--	--	--
Soft maple	214	103	--	--	31	40	18	8	--	12	2	--	--
Basswood	624	160	--	104	154	140	30	19	12	--	5	--	--
Cottonwood	4,127	897	810	1,199	402	221	160	128	79	72	60	76	23
Willow	837	612	--	29	121	17	30	13	6	5	2	2	--
Other soft hdwds.	881	498	105	35	59	113	37	18	11	--	3	2	--
Other hardwoods	1,679	138	108	951	301	--	181	--	--	--	--	--	--
Other white oak	252	189	63	--	--	--	--	--	--	--	--	--	--
Black cherry	130	130	--	--	--	--	--	--	--	--	--	--	--
Total hardwoods	23,189	5,852	4,252	6,285	2,775	1,494	1,168	621	291	160	122	135	34
All species	534,665	225,506	105,069	94,587	52,927	24,894	14,953	8,627	4,159	2,040	1,128	739	36

Table 10.--Net volume of timber on commerical forest land, by class of timber, and softwoods and hardwoods, South Dakota, 1962

(Million cubic feet)

Class of timber	All species	Softwoods	Hardwoods
Sawtimber trees:			
Saw-log portion	666	626	40
Upper-stem portion	74	67	7
Total sawtimber	740	693	47
Poletimber trees	345	314	31
All growing-stock trees	1,085	1,007	78
Rough trees	10	1	9
Rotten trees	21	3	18
Salvable dead trees	6	6	--
Total, all timber	1,122	1,017	105

Table 11.--Net volume of growing stock and sawtimber on commercial forest land, by ownership classes, and softwoods and hardwoods, South Dakota, 1962

Ownership class	Growing stock (Million cubic feet)			Sawtimber (Million board feet)[1]		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
National Forest	781	781	(2/)	2,687	2,687	(3/)
Other public	76	62	14	253	219	34
Farmer and miscellaneous private[4]	228	164	64	776	563	213
All ownerships	1,085	1,007	78	3,716	3,469	247

---

[1] International ¼-inch rule.

[2] Less than 0.5 million cubic feet.

[3] Less than 0.5 million board feet.

[4] Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 12.--Net volume of growing stock on commercial forest land, by species and diameter classes, South Dakota, 1962

(Million cubic feet)

Species	Diameter class (inches at breast height)										
	All classes	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0 and larger
Softwoods:											
Ponderosa pine	961	127	179	151	158	127	88	57	40	34	(1/)
White spruce	46	3	5	4	6	9	7	3	3	6	--
Total softwoods	1,007	130	184	155	164	136	95	60	43	40	(1/)
Hardwoods:											
Bur oak	4	1	1	1	1	(1/)	(1/)	(1/)	(1/)	--	--
Hard maple	(1/)	(1/)	--	(1/)	--	--	--	--	--	--	--
Ash	19	4	3	3	3	3	2	1	(1/)	(1/)	--
Black walnut	(1/)	--	--	--	--	--	--	--	(1/)	(1/)	--
Elm	16	1	1	2	3	2	2	1	1	2	1
Hackberry	(1/)	(1/)	(1/)	(1/)	(1/)	--	--	--	--	--	--
Soft maple	1	--	(1/)	(1/)	(1/)	(1/)	--	1	(1/)	--	--
Basswood	2	(1/)	1	1	(1/)	(1/)	(1/)	--	(1/)	--	--
Cottonwood	28	3	2	2	3	3	2	2	3	6	2
Willow	1	(1/)	1	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	(1/)	--
Other hardwoods	7	2	1	1	2	1	(1/)	--	(1/)	(1/)	--
Total hardwoods	78	11	10	10	12	9	6	5	4	8	3
All species	1,085	141	194	165	176	145	101	65	47	48	3

---

[1] Less than 0.5 million cubic feet.

Table 13.--Net volume of sawtimber on commercial forest land, by species and diameter classes, South Dakota, 1962

(Million board feet)[1]

Species	Diameter class (inches at breast height)								
	All classes	9.0-10.9[2]	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0 and larger
Softwoods:									
Ponderosa pine	3,268	748	752	608	456	300	217	185	2
White spruce	201	26	33	44	34	16	15	33	--
Total softwoods	3,469	774	785	652	490	316	232	218	2
Hardwoods:									
Bur oak	6	--	3	1	1	(3/)	1	--	--
Ash	40	--	12	14	7	3	2	2	--
Black walnut	1	--	--	--	--	--	(3/)	1	--
Elm	58	--	11	11	9	7	6	11	3
Hackberry	(3/)	--	(3/)	--	--	--	--	--	--
Soft maple	3	--	(3/)	1	--	1	1	--	--
Basswood	1	--	1	(3/)	(3/)	--	(3/)	--	--
Cottonwood	120	--	14	15	11	14	14	38	14
Willow	7	--	2	1	1	1	(3/)	2	--
Other hardwoods	11	--	9	1	1	--	(3/)	(3/)	--
Total hardwoods	247	--	52	44	30	26	24	54	17
All species	3,716	774	837	696	520	342	256	272	19

---

[1] International ¼-inch rule.

[2] Softwoods only.

[3] Less than 0.5 million board feet.

Table 14.--Net volume of sawtimber on commercial forest land, by species and log grades, South Dakota, 1962

(Million board feet)[1]

Species	Log grade				
	All grades	1	2	3	4
Softwoods:					
Ponderosa pine	3,268	66	150	344	2,708
White spruce[2]	201	4	9	21	167
Total softwoods	3,469	70	159	365	2,875
Hardwoods:					
Bur oak	6	--	(3/)	5	1
Ash	40	1	8	21	10
Black walnut	1	1	(3/)	(3/)	--
Elm	58	10	13	25	10
Hackberry	(3/)	(3/)	(3/)	(3/)	(3/)
Soft maple	3	1	(3/)	1	1
Basswood	1	(3/)	1	(3/)	(3/)
Cottonwood	120	29	13	70	8
Willow	7	--	(3/)	5	2
Other hardwoods	11	--	2	6	3
Total hardwoods	247	42	37	133	35
All species	3,716	112	196	498	2,910

---

[1] International ¼-inch rule.

[2] Spruce not graded but volume has been apportioned among grade classes on the basis of ponderosa pine.

[3] Less than 0.5 million board feet.

Table 15.--Volume of growing stock and sawtimber on commercial forest land, by stand-size classes and by softwoods and hardwoods, South Dakota, 1962

Stand-size class	All species	Softwoods	Hardwoods
	GROWING STOCK (Million cubic feet)		
Sawtimber stands	776	729	47
Poletimber stands	304	274	30
Sapling and seedling stands	4	3	1
Nonstocked areas	1	1	(1/)
All classes	1,085	1,007	78
	SAWTIMBER (Million board feet)[2]		
Sawtimber stands	3,122	2,917	205
Poletimber stands	578	540	38
Sapling and seedling stands	12	8	4
Nonstocked areas	4	4	(1/)
All classes	3,716	3,469	247

[1] Less than 0.5 million feet
[2] International ¼-inch rule

Table 16.--Net annual growth[1] and removals[2] of growing stock on commercial forest land, by species, South Dakota, 1962

(Thousand cubic feet)

Species	Net annual growth	Annual timber removals
Softwoods:		
Ponderosa pine	25,880	12,066
White spruce	1,075	1
Total softwoods	26,955	12,067
Hardwoods:		
Bur oak	190	233
Hard maple	20	0
Ash	650	237
Elm	460	72
Hackberry	40	0
Soft maple	50	0
Basswood	140	0
Cottonwood	1,670	707
Willow	110	11
Other hardwoods	169	2
Total hardwoods	3,499	1,262
All species	30,454	13,329

---

[1] Average net annual growth for the last decade estimated to be 29,594,000 cubic feet.

[2] Average annual timber removals for the last decade estimated to be 13,245,000 cubic feet.

Table 17.--Net annual growth[1] and removals[2] of growing stock on commercial forest land, by ownership classes, and softwoods and hardwoods, South Dakota, 1962

(Thousand cubic feet)

Ownership class	Net annual growth			Annual timber removals		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
National Forest	20,086	20,083	3	10,978	10,978	0
Other public	2,592	1,975	617	232	114	118
Farmer and miscellaneous private[3]	7,776	4,897	2,879	2,119	975	1,144
All ownerships	30,454	26,955	3,499	13,329	12,067	1,262

---

[1] Average net annual growth for the last decade estimated to be 29,594,000 cubic feet.

[2] Average annual timber removals for the last decade estimated to be 13,245,000 cubic feet.

[3] Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 18.--Net annual growth[1] and removals[2] of sawtimber on commercial forest land, by species, South Dakota, 1962

(Thousand board feet)[3]

Species	Net annual growth	Annual timber removals
Softwoods:		
Ponderosa pine	86,460	53,257
White spruce	4,598	5
Total softwoods	91,058	53,262
Hardwoods:		
Bur oak	660	619
Ash	2,410	600
Elm	2,050	204
Hackberry	40	0
Soft maple	350	0
Basswood	120	0
Cottonwood	5,400	3,841
Willow	380	25
Other hardwoods	379	17
Total hardwoods	11,789	5,306
All species	102,847	58,568

---

[1] Average net annual growth for the last decade estimated to be 101,087,000 board feet.

[2] Average annual timber removals for the last decade estimated to be 56,475,000 board feet.

[3] International ¼-inch rule.

Table 19.--Net annual growth[1] and removals[2] of sawtimber on commercial forest land, by ownership classes, and softwoods and hardwoods, South Dakota, 1962

(Thousand board feet)[3]

Ownership class	Net annual growth			Annual timber removals		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
National Forest	67,988	67,986	2	49,065	49,065	0
Other public	8,919	7,155	1,764	661	412	249
Farmer and miscellaneous private[4]	25,940	15,917	10,023	8,842	3,785	5,057
All ownerships	102,847	91,058	11,789	58,568	53,262	5,306

---

[1] Average net annual growth for the last decade estimated to be 101,087,000 board feet.

[2] Average annual timber removals for the last decade estimated to be 56,475,000 board feet.

[3] International ¼-inch rule.

[4] Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 20.--Mortality[1] of growing stock and sawtimber on commercial forest land, by species, South Dakota, 1962

Species	Growing stock	Sawtimber
	Thousand cubic feet	Thousand board feet[2]
Softwoods:		
Ponderosa pine	1,214	4,251
White spruce	251	1,308
Total softwoods	1,465	5,559
Hardwoods:		
Bur oak	10	--
Ash	330	290
Elm	60	90
Cottonwood	240	80
Other hardwoods	71	155
Total hardwoods	711	615
All species	2,176	6,174

---

[1] Average annual mortality for the last decade estimated to be 3,036,000 cubic feet and 7,934,000 board feet.

[2] International ¼-inch rule.

Table 21.--Mortality[1] of growing stock and sawtimber on commercial forest land, by ownership classes, and softwoods and hardwoods, South Dakota, 1962

Ownership class	Growing stock (Thousand cubic feet)			Sawtimber (Thousand board feet)[2]		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
National Forest	1,218	1,218	(3/)	4,476	4,474	2
Other public	208	66	142	394	306	88
Farmer and miscellaneous private[4]	750	181	569	1,304	779	525
All ownerships	2,176	1,465	711	6,174	5,559	615

---

[1] Average annual mortality for the last decade estimated to be 3,036,000 cubic feet and 7,934,000 board feet.

[2] International ¼-inch rule.

[3] Less than 0.5 thousand cubic feet.

[4] Forest industry has been combined with farmer and miscellaneous private to avoid disclosure of holdings of an individual owner.

Table 22.--Mortality[1] of growing stock and sawtimber on commercial forest land, by causes, and softwoods and hardwoods, South Dakota, 1962

Cause	Growing stock (Thousand cubic feet)			Sawtimber (Thousand board feet)[2]		
	All species	Softwoods	Hardwoods	All species	Softwoods	Hardwoods
Fire	--	--	--	--	--	--
Insects	343	343	--	1,528	1,528	--
Disease	1,228	827	401	3,526	3,141	385
Other and unknown	605	295	310	1,120	890	230
All causes	2,176	1,465	711	6,174	5,559	615

---

[1] Average annual mortality for the last decade estimated to be 3,036,000 cubic feet and 7,934,000 board feet.
[2] International ¼-inch rule.

Table 23.--Output of timber products, by source of material and softwoods and hardwoods, South Dakota, 1962

Product and species group	Standard units	Total output: Number of units	Total output: Thousand cubic feet	Roundwood products: Number of units	Roundwood products: Thousand cubic feet	Plant byproducts: Number of units	Plant byproducts: Thousand cubic feet
Saw logs:							
Softwood	M bd. ft.[1]	38,958	6,493	38,958	6,493	0	0
Hardwood	M bd. ft.[1]	1,200	165	1,200	165	0	0
Total	M bd. ft.[1]	40,158	6,658	40,158	6,658	0	0
Veneer logs and bolts:							
Softwood	M bd. ft.[1]	0	0	0	0	0	0
Hardwood	M bd. ft.[1]	1,532	199	1,532	199	0	0
Total	M bd. ft.[1]	1,532	199	1,532	199	0	0
Pulpwood:							
Softwood	Std. cords[2]	41,000	3,564	34,000	3,060	7,000	504
Hardwood	Std. cords[2]	0	0	0	0	0	0
Total	Std. cords[2]	41,000	3,564	34,000	3,060	7,000	504
Cooperage:							
Softwood	M bd. ft.[1]	0	0	0	0	0	0
Hardwood	M bd. ft.[1]	0	0	0	0	0	0
Total	M bd. ft.[1]	0	0	0	0	0	0
Piling:							
Softwood	M linear ft.	12	10	12	10	0	0
Hardwood	M linear ft.	0	0	0	0	0	0
Total	M linear ft.	12	10	12	10	0	0
Poles:							
Softwood	M pieces	92	545	92	545	0	0
Hardwood	M pieces	6	25	6	25	0	0
Total	M pieces	98	570	98	570	0	0

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Table 23 (con.)

Product and species group	Standard units	Total output		Roundwood products		Plant byproducts	
		Number of units	Thousand cubic feet	Number of units	Thousand cubic feet	Number of units	Thousand cubic feet
Mine timbers (Round):							
Softwood	M cu. ft.	0	0	0	0	0	0
Hardwood	M cu. ft.	0	0	0	0	0	0
Total	M cu. ft.	0	0	0	0	0	0
Posts (Round and split):							
Softwood	M pieces	746	754	746	754	0	0
Hardwood	M pieces	100	79	100	79	0	0
Total	M pieces	846	833	846	833	0	0
Other:[3]							
Softwood	M cu. ft.	447	447	447	447	0	0
Hardwood	M cu. ft.	158	158	125	125	33	33
Total	M cu. ft.	605	605	572	572	33	33
Total industrial products:							
Softwood			11,813		11,309		504
Hardwood			626		593		33
Total			12,439		11,902		537
Fuelwood:							
Softwood	Std. cords	7,931	528	6,931	456	1,000	72
Hardwood	Std. cords	24,500	1,513	23,124	1,428	1,376	85
Total	Std. cords	32,431	2,041	30,055	1,884	2,376	157
All products:							
Softwood			12,341		11,765		576
Hardwood			2,139		2,021		118
Total			14,480		13,786		694

[1] International ¼-inch rule.

[2] Rough-wood basis (includes chips converted to equivalent standard cords).

[3] Mostly miscellaneous farm timbers.

Table 24.--Output of roundwood products by source, and softwoods and hardwoods, South Dakota, 1962

(Thousand cubic feet)

Product and species group	All sources	Growing stock trees 1/			Rough and rotten trees 1/	Salvable dead trees 1/	Other sources 2/
		Total	Sawtimber	Poletimber			
Industrial products:							
Saw logs:							
Softwood	6,493	6,428	6,428	0	0	65	0
Hardwood	165	163	163	0	1	0	1
Total	6.658	6.591	6.591	0	1	65	1
Veneer logs and bolts:							
Softwood	0	0	0	0	0	0	0
Hardwood	199	199	199	0	0	0	0
Total	199	199	199	0	0	0	0
Pulpwood:							
Softwood	3,060	3,060	918	2,142	0	0	0
Hardwood	0	0	0	0	0	0	0
Total	3.060	3.060	918	2,142	0	0	0
Miscellaneous industrial products:							
Cooperage:							
Softwood	0	0	0	0	0	0	0
Hardwood	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0
Piling:							
Softwood	10	10	10	0	0	0	0
Hardwood	0	0	0	0	0	0	0
Total	10	10	10	0	0	0	0
Poles:							
Softwood	545	512	508	4	1	32	0
Hardwood	25	23	7	16	2	0	0
Total	570	535	515	20	3	32	0
Mine timbers (Round):							
Softwood	0	0	0	0	0	0	0
Hardwood	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0
Posts (Round and split):							
Softwood	754	729	541	188	0	0	25
Hardwood	79	34	2	32	0	0	45
Total	833	763	543	220	0	0	70
Other:							
Softwood	447	402	402	0	0	45	0
Hardwood	125	125	75	50	0	0	0
Total	572	527	477	50	0	45	0
All miscellaneous industrial products:							
Softwood	1,756	1,653	1,461	192	1	77	25
Hardwood	229	182	84	98	2	0	45
Total	1,985	1,835	1,545	290	3	77	70
All industrial products:							
Softwood	11,309	11,141	8,807	2,334	1	142	25
Hardwood	593	544	446	98	3	0	46
Total	11,902	11,685	9,253	2,432	4	142	71

(con. next page)

Table 24 (con.)

Product and species group	All sources	Growing stock trees[1]			Rough and rotten trees[1]	Salvable dead trees[1]	Other sources[2]
		Total	Sawtimber	Poletimber			
Fuelwood:							
Softwood	456	189	104	85	91	38	138
Hardwood	1,428	638	352	286	308	21	461
Total	1,884	827	456	371	399	59	599
All products:							
Softwood	11,765	11,330	8,911	2,419	92	180	163
Hardwood	2,021	1,182	798	384	311	21	507
Total	13,786	12,512	9,709	2,803	403	201	670

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[1] On commercial forest land.

[2] Includes trees less than 5.0 inches in diameter, treetops and limbs from commercial forest areas or material from noncommercial forest land or nonforest land such as fence rows or suburban areas.

Table 25.--Timber removals[1] from growing stock on commercial forest land, by items, and softwoods and hardwoods, South Dakota, 1962

(Thousand cubic feet)

Item	All species	Softwoods	Hardwoods
Roundwood products:			
Saw logs	6,591	6,428	163
Veneer logs and bolts	199	0	199
Pulpwood	3,060	3,060	0
Cooperage logs and bolts	0	0	0
Piling	10	10	0
Poles	535	512	23
Mine timbers	0	0	0
Posts	763	729	34
Other	527	402	125
Fuelwood	827	189	638
All products	12,512	11,330	1,182
Logging residues	777	697	80
Other removals	40	40	0
Total removals	13,329	12,067	1,262

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[1] Annual timber removals for the last decade estimated to be 13,245,000 cubic feet.

Table 26.--Timber removals[1/] from live sawtimber on commercial forest lands, by items, and softwoods and hardwoods, South Dakota, 1962

(Thousand board feet)[2/]

Item	All species	Softwoods	Hardwoods
Roundwood products:			
Saw logs	39,742	38,568	1,174
Veneer logs and bolts	1,530	0	1,530
Pulpwood	5,508	5,508	0
Cooperage logs and bolts	0	0	0
Piling	60	60	0
Poles	2,892	2,864	28
Mine timbers	0	0	0
Posts	408	396	12
Other	2,903	2,415	488
Fuelwood	2,280	520	1,760
All products	55,323	50,331	4,992
Logging residues	3,228	2,914	314
Other removals	17	17	--
Total removals	58,568	53,262	5,306

[1/] Annual timber removals for the last decade estimated to be 56,475,000 board feet.

[2/] International ¼-inch rule.

Table 27.--Volume of unused residues at primary manufacturing plants, by industry and type of residue, and softwoods and hardwoods, South Dakota, 1962

(Thousand cubic feet)

Species group and type of residues	All industries	Lumber	Veneer and plywood	Other
Softwoods:				
Coarse[1/]	1,144	931	0	213
Fine[2/]	1,603	1,603	0	0
Total	2,747	2,534	0	213
Hardwoods:				
Coarse[1/]	89	47	42	0
Fine[2/]	101	33	68	0
Total	190	80	110	0
All species:				
Coarse[1/]	1,233	978	42	213
Fine[2/]	1,704	1,636	68	0
Total	2,937	2,614	110	213

[1/] Material such as slabs, edgings, and veneer cores.

[2/] Material such as sawdust and shavings.

Table 28.--Projections of available cut, net annual growth, and inventory of growing stock and sawtimber on commercial forest land, South Dakota, 1962-92[1]

Species group	Growing stock (Million cubic feet) 1962 (Inventory year)	Growing stock (Million cubic feet) 1972 (Inventory year plus 10 years)	Growing stock (Million cubic feet) 1982 (Inventory year plus 20 years)	Growing stock (Million cubic feet) 1992 (Inventory year plus 30 years)	Sawtimber (Million board feet)[2] 1962 (Inventory year)	Sawtimber (Million board feet)[2] 1972 (Inventory year plus 10 years)	Sawtimber (Million board feet)[2] 1982 (Inventory year plus 20 years)	Sawtimber (Million board feet)[2] 1992 (Inventory year plus 30 years)
Softwoods:								
Cut	[3]13	21	31	38	[3]60	93	118	131
Growth	27	31	35	39	91	104	110	114
Inventory	1,007	1,144	1,213	1,234	3,469	3,739	3,755	3,631
Hardwoods:								
Cut	[3]1	2	2	2	[3]6	6	6	7
Growth	3	3	3	3	12	10	10	10
Inventory	78	91	105	117	247	284	319	346
Total								
Cut	14	23	33	40	[3]66	99	124	138
Growth	30	34	38	42	103	114	120	124
Inventory	1,085	1,235	1,318	1,351	3,716	4,023	4,074	3,977

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[1] These projections assume that (1) There will be no major reduction in the area of commercial forest land; (2) timber will maintain its market position relative to competitive materials and demands for timber products in South Dakota will continue to increase at about the present rate; and (3) timber management will become more intensive, especially with respect to improving the number, spacing, vigor, and age class distribution of trees.

[2] International ¼-inch rule.

[3] 1962 cut estimates are trend level rather than actual.

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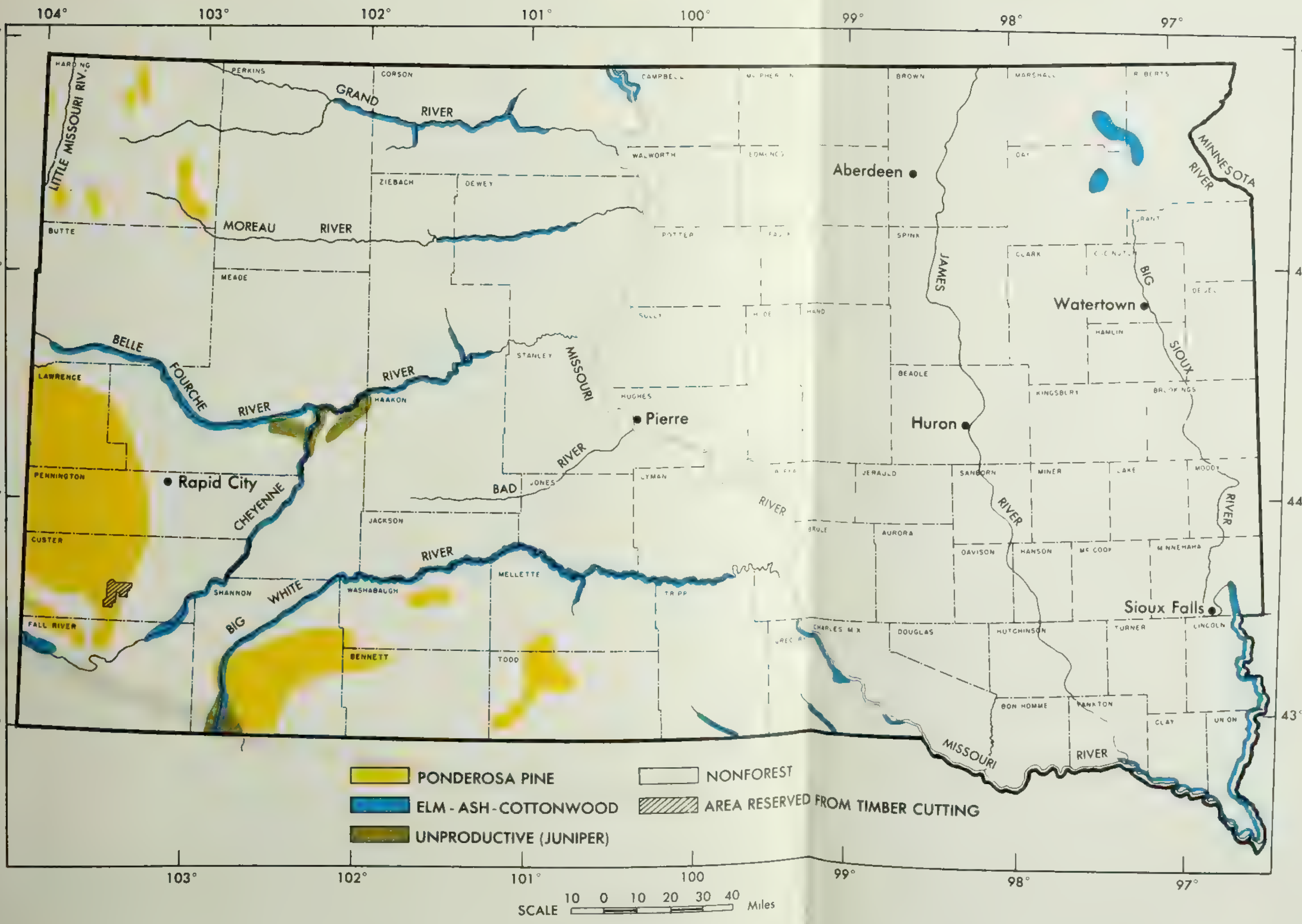

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